COORDINATION

GATE 2005

1. The complexes $\left[Co(NH_3)_4(H_2O)Cl\right]Br_2$ and $\left[Co(NH_3)_4Br_2\right]Cl.H_2O$ are examples of
   (a) ionization isomerism (b) linkage isomerism
   (c) geometric isomerism (d) optical isomerism
2. In the trigonal bipyramidal crystal field, the d orbital with the highest energy is
   (a) d_{xy} (b) $d^2_{x-y^2}$ (c) d_{yz} (d) d^2_z
3. The magnetic moment of the complex $K_3\left[CoF_6\right]$ is 5.0 m_B. The total stabilization energy will be
   (a) $-0.4D_0$ (b) $-0.4\ D_0 + P$ (c) $-2.4\ D_0 + 3P$ (d) $-1.8\ D_0 + 3P$
4. The rate of exchange of cyanide ligands in the complexes (i) $\left[Ni(CN)_4\right]^{2-}$, (ii) $\left[Mn(CN)_6\right]^{3-}$ and (iii) $\left[Cr(CN)_6\right]^{3-}$ by ^{14}CN follow the order.
   (a) ii > i > iiii (b) iii > i > ii (c) i > iii > ii (d) i > ii > iii
5. Ligand field stabilization energies are smaller for lanthanides compared to transition metals in the same oxidation state because
   (a) size of lanthanide ions are larger (b) forbitals interact less effectively with ligands
   (c) size of lanthanide ions are smaller (d) lanthanides favour oxygen donor ligands
6. The number of possible d – d transitions wll be
   (a) one (b) two (c) three (d) four

GATE 2006

7. The pair of ions that most commonly forms complexes with coordination number 2 is
   (a) Cd (II) and Hg(II) (b) Cu (II) and Hg(I) (c) Cd (II) and Hg(I) (d) Cu (I) and Hg(II)
8. The xperiemental magnetic moment of $K_3\left[Fe(CN)_6\right]$ is 2.3 μ_B and is attributable to the
   (a) spin-only value of a low - spin (b) spin-only vlaue of a high-spin Fe.
   (c) low-spin Fe with orbital contribution (d) high-spin Fe with orbital contribution.
9. The set of ions expected to show Jahn-Teller distortion in their complexes is
   (a) Ti(III), Cu(II), High-spin Fe(III) (b) Cu(I), Ni(II), High-spin Fe(III)
   (c) Cu(II), Low-spin Fe(III), Ti(III) (d) Low-spin-Fe (III), Mn(II), Cu(I)
10. The series with correct order of increasing Δ_0 in their complexes is:
    (a) $I^- < PR_3 < CH_3^- < CO$ (b) $PR_3 < CH_3^- < I^- < CO$ (c) $CH_3^- < PR_3 < I^- < CO$ (d) $I^- < CH_3^- < PR_3 < CO$

QUANTA CHEMISTRY CLASSES

11. Coordinate water molecules of a Cd(II) complex can be successively replaced by Br^- finally to result in $[CdBr_4]^{2-}$. In this process, the fourth equilibirum constant is observed to be higher than the third one, because
    (a) equilibrium constant for the last step is always the highest.
    (b) three molecules of H_2O are released during the fourth step.
    (c) the aquo-Cd(II) species is octahedra.
    (d) the aquo-Cd(II) species is octahedra.
12. The CORRECT statement regarding the thermodynamic stability and kinetic reactivity of metal ion complexes is that
    (a) more stable complexes are less reactive.
    (b) there exists a dependence on the bulkness of the ligand
    (c) there exists no direct relation between these two phenomenon.
    (d) there exists a dependence on the size o the metla ion.
13. The CORRECT order of the rate of exchange of water molecules between the coordination sphere and the bulk is:
    (a) $Cr^{3+} < Al^{3+} < Ni^{2+}$
    (b) $Cr^{3+} < Al^{3+} < Ni^{2+} < Cr^{2+}$
    (c) $Cr^{3+} < Ni^{2+} < Cr^{2+} < Al^{3+}$
    (d) $Cr^{3+} < Cr^{2+} < Al^{3+} < Ni^{2+}$
14. The CORRECT order of the soft character (as per HSAB principle) of the central metal ion is
    (a) $[CrO_4]^{2-} < [CrCl_4] < [Cr(bipy)_3] < [Cr(CO)_5]^{2-}$
    (b) $[CrCl_4]^- < [Cr(bipy)_3] < [CrCO_4]^{2-} < [Cr(CO)_5]^{2-}$
    (c) $[CrCO_4]^{2-} < [Cr(bipy)_3] < [Cr(CO)_5]^{2-} < [CrCl_4]^-$
    (d) $[CrCl_4]^- < [CrCO_4]^{2-} < [Cr(CO)_5]^{2-} < [Cr(bipy)_3]$
15. The crystal structure of Pb_3O_4 contains
    (a) octahedral and tetrahedra units
    (b) only octahedral units
    (c) octahedral and pyramidal units
    (d) octahedral and square-planar units
16. $[Ru(2,2'-bipyridyl)_3]^+$, when it absorbs at 452 nm, is a very good oxidizing as well as reducing agent due to the formation of
    (a) $[Ru^{I}(2,2'-bipyridyl)_3]^+$
    (b) $[Ru^{I}(2,2'-bipyridyl)_2(2,2'\ bipyridyl^+)]^{2+}$
    (c) $[Ru^{III}(2,2'-bipyridyl)_3]^{3+}$
    (d) $[Ru^{III}(2,2'-bipyridyl)_2(2,2'-bipyridyl)]^{2+}$

GATE 2007

17. Consider the reactions
    1. $[Cr(H_2O)_6]^{2+} + [CoCl(NH_3)_5]^{2+} \rightarrow [Co(NH_3)_5(H_2O)]^{2+} + [CrCl(H_2O)_5]^{2+}$
    2. $[Fe(CN)_6]^{4-} + [Mo(CN)_8]^{3-} \rightarrow [Fe(CN)_6]^{3-+} + [Mo(CN)_8]^{4-}$

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Which one of the following is the correct statement?

(i) Both involve an inner sphere mechanism.

(ii) Both involve an outer sphere mechanism

(iii) Reaction 1 follows inner sphere and reaction 2 follows outer sphere mechanism

(iv) Reaction 1 follows outer sphere and reaction 2 follows inner sphere mechanism.

(a) i (b) ii (c) iv (d) iii

18. The compound which shows L ← M charge transfer is

(a) $Ni(CO)_4$ (b) $K_2Cr_2O_7$ (c) HgO (d) $\left[Ni(H_2O)_6\right]^{2+}$

19. The reaction of $\left[PtCl_4\right]^{2-}$ with NH_3 gives rise to

(a) $\left[PtCl_4(NH_3)_2\right]^{2-}$ (b) trans $-\left[PtCl_2(NH_3)_2\right]$

(c) $\left[PtCl_2(NH_3)_4\right]$ (d) cis $-\left[PtCl_2(NH_3)_2\right]$

GATE 2008

20. The total number of isomers of $Co(en)_2Cl_2$ (en = ethylenedamine) is

(a) 4 (b) 3 (c) 6 (d) 5

21. The magnetic moment of $\left[Ru(H_2O_6)\right]^{2+}$ corresponds to the presence of

(a) four unpaired electrons (b) three unpaired electrons

(c) two unpaired electrons (d) zero unpaired electrons

22. The spectroscopic ground state symbol and the total number of electronic transitions of $\left[Ti(H_2O_6)\right]^{2+}$ are

(a) $^3T_{lg}$ and 2 (b) $^3A_{2g}$ and 3 (c) $^3T_{1g}$ and 3 (d) $^3A_{2g}$ and 2

23. The structure of the complexes $\left[Cu(NH_3)_4\right](ClO_4)_2$ and $\left[Cu(NH_3)_4\right](ClO)_4$ in solution respectively

(a) square planar and tetrahedral (b) octahedral and square pyramidal

(c) octahedral and trigonal bipyramidal (d) tetrahedral and square planar

24. The expected magnetic moments of the first – row transition metal complexes and those of the lanthanide metal complexes are usually calculated using

(a) $\mu_{s.o}$ equation (s.o. = spin only) for both lanthanide and transition metal complexes

(b) $\mu_{s.o}$ equation for lanthanide metal complexes and μ_j equation for transition metal complexes

(c) $\mu_{s.o}$ equation for transition metal complexes and μ_j equation for lanthanide metal complexes

(d) μ_{L+S} equation for transition metal complexes and $\mu_{s.o}$ equation for lanthanide metal complexes

25. Among the compounds Fe_3O_4, $NiFe_2O_4$ and Mn_3O_4

(a) $NiFe_2O_4$ and Mn_3O_4 ara normal spinels (b) Fe_3O_4 and Mn_3O_4 are normal spinels

(c) Fe_3O_4 and Mn_3O_4 are inverse spinels (d) Fe_3O_4 and $NiFe_2O_4$ are inverse spinels

GATE 2009

26. The corrrect statement about the Cu-N bond distances in $\left[Cu(NH_3)\right]^{2+}$ is:

(a) all the bond distance are equal

(b) the axial bonds are longer than the equatorial ones.

(c) the equatorial bonds are longer than the axial ones.

QUANTA CHEMISTRY CLASSES

(d) all the bond distances are unequal.

27. In the transformation of oxyhaemoglobin to deoxyhaemoglobin

(a) Fe^{2+} in the low spin state changes to Fe^{2+} in the high spin state

(b) Fe^{2+} in the low spin state changes to Fe^{3+} in the low spin state.

(c) Fe^{2+} in the high spin state changes to Fe^{2+} in the low spin state

(d) Fe^{2+} in the high spin state changes to Fe^{3+} in the high spin state.

28. Designate the following complexes X, Y and Z as inert or labile:

$X = \left[Al(C_2O_4)_3\right]^{3-}$, $Y = \left[V(H_2O)_6\right]^{2+}$, $Z = \left[Cr(C_2O_4)_3\right]^{3-}$

(a) X and Y are inert; Z is labile (b) X and Z are labile; Y is inert.

(c) X is inert; Y and Z are labile (d) X is labile; Y and Z are inert.

GATE 2010

29. The number of unpaired electron(s) present in the species $\left[Fe(H_2O)_5(NO)\right]^{2+}$ which is formed during 'brown ring test' is:

(a) 2 (b) 3 (c) 4 (d) 5

30. Fe_3O_4 and Co_3O_4 are metal oxides having spinel structure. Considering their CFSEs, the correct statement regarding their structure is

(a) both have normal spinel structure

(b) both have inverse spinel structure

(c) Fe_3O_4 has normal and Co_3O_4 has inverse spinel structure

(d) Fe_3O_4 has inverse and Co_3O_4 has normal spinel structure

31. The mechanism of the reaction between $\left[Fe(CN)_6\right]^{4-}$ and $\left[Fe(bpy_3)\right]^{3+}$ (bpy = 2, 2' – bipyridine) is

(a) outer – sphere electron – transfer (b) inner – sphere electron – transfer

(c) self – exchange reaction (d) ligand – exchange followed by electron transfer

32. The d – d absorption band of $\left[Fe(H_2O)_6\right]^{2+}$ is split due to

(a) presence of octahedral geometry

(b) static Jahn – Teller distortion

(c) dynamic Jahn – Teller distortion

(d) presence of trigonal bipyramidal geometry

33. The crystal – field symbol for the ground – state of $\left[Mn(CN)_6\right]^{4-}$ is

(a) $^2T_{2g}$ (b) $^1A_{1g}$ (c) ^5E_g (d) $^6A_{1g}$

34. $\left[CoCl_4\right]^{2-}$ is a blue coloured complex. Controlled – treatment of this complex with watger generates two isomeric light pink coloure complexes of composition $\left[Co(H_2O)_4Cl_2\right]$. Identify the correct point groups for $\left[CoCl_4\right]^{2-}$ and two isomeric complexes $\left[Co(H_2O)_4Cl_2\right]$.

(a) D_{2h} and (C_{2v} and C_{2h}) (b) T_d and (C_{2v} and D_{4h})

(c) D_{4h} and (C_{2v} and D_{4h}) (d) T_d and (C_{2v} and C_{4v})

QUANTA CHEMISTRY CLASSES

GATE 2011

35. Jahn-Teller distortion of $CuSO_4.5H_2O$ acts to

(a) Raise symmetry

(b) Remove and electronic degeneracy

(c) Cause loss of H_2O ligand

(d) Promote a d-electron to an antibonding molecular orbital.

36. The complex that exists as a pair of enantiomers is

(a) trans-$[Co(H_2NCH_2CH_2NH_2)_2Cl_2]^+$ (b) cis-$[Co(NH_3)_4Cl_2]^+$

(c) $[Pt(PPh_3)(Cl)(Br)(CH_3)]^-$ (d) $[Co(H_2NCH_2CH_2NH_2)_3]^{3+}$

37. The crystal field stabilization energy (CFSE) value for $[jTi(H_2O)_6]^{3+}$ that has an absorption maximum at 492 nm is:

(a) 20, 325 cm^{-1} (b) 12, 195 cm^{-1} (c) 10, 162 cm^{-1} (d) 8, 130 cm^{-1}

38. In the isoelectronic series, VO_4^{3-}, CrO_4^{2-} and MnO_4^-, all members have intense charge transfer (CT) transitions. The INCORRECT statement is

(a) CT transitions are attributed to excitations of electrons from ligand (σ) to metal (e)

(b) MnO_4^- exhibits charge transfer at shortest wavelength among the three

(c) The wavelength of tjransitions increase in the order $VO_4^{3-} < CrO_4^{2-} < MnO_4^-$

(d) The charge on metal nucleus increases in the order $VO_4^{3-} < CrO_4^{2-} < MnO_4^-$

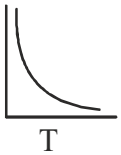
39. The increasing order of wavelength of absorption for the complex ions

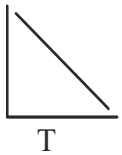
(i) $\left[Cr(NH_3)_6\right]^{3+}$ (ii) $\left[CrCl_6\right]^{3-}$ (iii) $\left[Cr(OH_2)_6\right]^{3+}$ (iv) $\left[Cr(CN)_6\right]^{3-}$, is

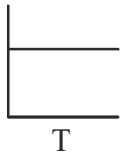
(a) iv < ii < i < iii (b) iv < iii < ii < i (c) iv < i < iii < ii (d) ii < iii < i < iv

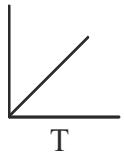
GATE 2012

40. The plot of χT versus T (where χ is molar magnetic susceptibility and T is the temperature) for a paramagnetic complex which strictly follows Curie equation is:

(a) 

(b) 

(c) 

(d) 

41. The complex with inverse – spinel structure is

(a) Co_3O_4 (b) Fe_3O_4 (c) $MgAlO_4$ (d) Mn_3O_4

42. The IUPAC nomenclature of $Na\left[PCl_6\right]$ is

(a) sodium hexachlorophosphine (V) (b) sodium hexachlorophosphate (V)

(c) sodium hexachlorophosphine (d) sodium hexachlorophosphite (V)

QUANTA CHEMISTRY CLASSES

43. Consider the following pairs of complexes

$\left[CoF(NH_3)_5\right]^{2+}$ and $\left[Cr(OH_2)_6\right]^{2+}$; $\left[Co(NH_3)_5(OH_2)\right]^{3+}$ and $\left[Cr(OH_2)_6\right]^{2+}$

$\left[Co(NH_3)_6\right]^{3+}$ and $\left[Cr(OH_2)_6\right]^{2+}$; $\left[CoI(NH_3)_5\right]^{2+}$ and $\left[Cr(OH_2)_6\right]^{2+}$

The electron transfer rate will be fastest in the pair.

(a) $\left[CoF(NH_3)_5\right]^{2+}$ and $\left[Cr(OH_2)_6\right]^{2+}$ (b) $\left[Co(NH_3)_5(OH_2)^{3+}\right]$ and $\left[Cr(OH_2)_6\right]^{2+}$

(c) $\left[Co(NH_3)_6\right]^{3+}$ and $\left[Cr(OH_2)_6\right]^{2+}$ (d) $\left[CoI(NH_3)_5\right]^{2+}$ and $\left[Cr(OH_2)_6\right]^{2+}$

GATE 2013

44. Among the following octahedral complexes, the one that has the highest enthalpy of hydration is

(a) $[CaH_2O_6]^{2+}$ (b) $[Mn(H_2O)_6]^{2+}$ (c) $[V(H_2O)_6]^{2+}$ (d) $[Cr(H_2O)_6]^{2+}$

45. The ground state term $[Ni(H_2O)_6]^{2+}$ is:

(a) $^3T_{1g}$ (b) $^3T_{2g}$ (c) $^3A_{2g}$ (d) $^4T_{1g}$

GATE 2014

46. The geometries of $Ni(CO)_4$ and $[NiCl_4]^{2-}$, respectively, are

(a) tetrahedral and square planar (b) square planar and tetrahedral

(c) tetrahedral and tetrahedral (d) square planar and square planar

47. The complexes $[Co(H_2O)_4Cl_2]NO_2$ and $[Co(H_2O)_4Cl(NO_2)]Cl$ are

(a) linkage isomers (b) positional isomers (c) ionization isomers (d) optical isomers

48. The number of microstates in term ^1G is _____

49. Amongst the following, the complex ion that would show strong Jahn-Teller distortion is

(a) $\left[Cr(H_2O)_6\right]^{+}$ (b) $\left[Ti(H_2O)_6\right]^{3+}$ (c) $\left[Co(H_2O)_6\right]^{2+}$ (d) $\left[Fe(H_2O)_6\right]^{2+}$

50. Amongst the following, the complex ion that is expected to the highest magnetic moment at room temperature is

(a) $\left[Ni(CN)_4\right]^{2-}$ (b) $\left[Fe(CN)_6\right]^{3-}$ (c) $\left[Cu(H_2O)_6\right]^{2+}$ (d) $\left[Co(CN)_6\right]^{3-}$

51. $MnCr_2O_4$ is

(a) normal spinel with total CFSE of –15.5 Dq (b) inverse spinel with total CFSE of –15.5 Dq

(c) normal spinel with total CFSE of –24 Dq (d) inverse spinel with total CFSE of –24 Dq

GATE 2015

52. The absorption spectrum of $\left[Ti(H_2O)_6\right]^{3+}$ in solution comprises of a maximum with a shoulder. The reason for the shoulder is

(a) ligand-to-metal charge transfer (LMCT)

(b) metal-to-ligand charge transfer (MLCT)

(c) Jahn-Teller distortion

(d) nephelauxetic effect.

QUANTA CHEMISTRY CLASSES

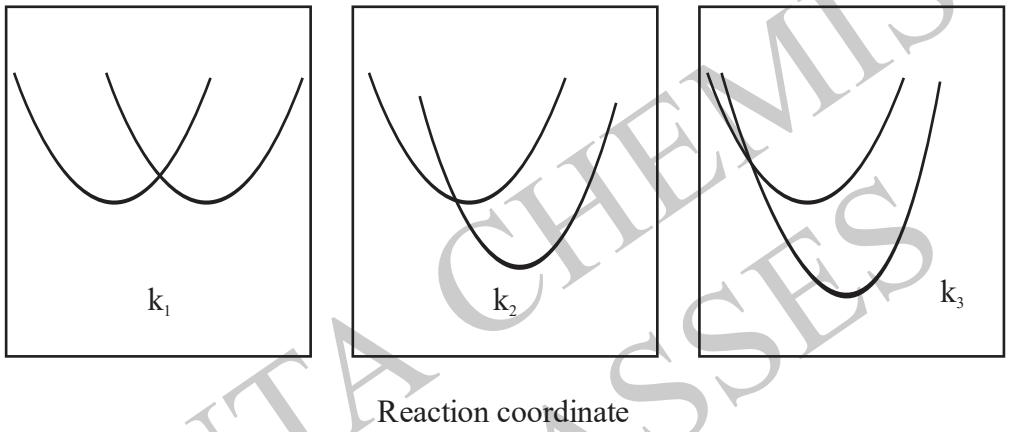
53. The intense red color of $\left[Fe(bpy)_3\right]^{2+}$ (bpy = 2, 2' -bipyridine) is due to)

(a) metal-to-ligand charge transfer (MLCT)
(b) ligand-to-metal charge transfer (LMCT)
(c) d-d transition
(d) inter-valence charge transfer (IVCT)

54. The complexes $K_2[NiF_6]$ and $K_3[CoF_6]$ are

(a) both paramagnetic
(b) both diamagnetic
(c) paramagnetic and diamagnetic, respectively
(d) diamagnetic and paramagnetic, respectively

55. The potential energy (PE) versus reaction coordinate diagrams for electron transfer reactions with rate constants k_2, k_2 and k_3, are given below. The increasing order of the rate constants is



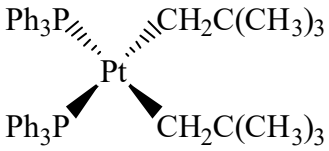
(a) $k_2 < k_3 < k_1$ (b) $k_2 < k_1 < k_3$ (c) $k_3 < k_2 < k_1$ (d) $k_3 < k_1 < k_2$

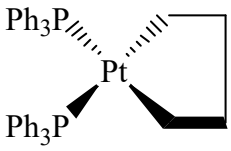
GATE 2016

56. In the first row high-spin transition metal complexes $[M(H_2O)_6]Cl_2$ with d^5 and d^7 metal ions, the d-d transitions are

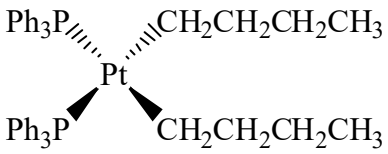
(a) spin-forbidden for both
(b) spin-allowed for both
(c) spin-forbidden for d^5 and spin-allowed for d^7
(d) spin-allowed for d^5 and spin-forbidden for d^7

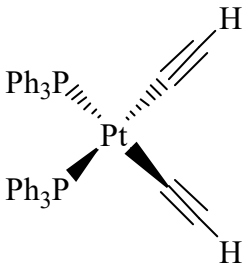
57. Among the given platinum(II) complexes, the one that is thermally the most unstable is

(a) 

(b) 

QUANTA CHEMISTRY CLASSES

(c) 

(d) 

58. According to Irving-Williams series, the number of d electrons for the first row transition metal (M) ion having the highest overall stability constant (log β) for $[M(EDTA)]^{2-}$ is _____

59. The magnitude of the difference in the crystal field stabilization energies, in Δ_0 (irnoring pairing energy), of $\left[Fe(H_2O)_6\right]^{2+}$ and $\left[Fe(CN)_6\right]^{4-}$ is _____

60. In the electronic spectra of $[CrF_6]^{3-}$, absorption bands observed at 670, 440 and 290 nm are, respectively, due to the transitions.

(a) $^4A_{2g} \rightarrow {}^4T_{1g}(P)$, $^4A_{2g} \rightarrow {}^4T_{1g}(F)$ and $^4A_{2g} \rightarrow {}^4T_{2g}$

(b) $^4A_{2g} \rightarrow {}^4T_{1g}(P)$, $^4A_{2g} \rightarrow {}^4T_{2g}$ and $^4A_{2g} \rightarrow {}^4T_{2g}(F)$

(c) $^4A_{2g} \rightarrow {}^4T_{1g}(F)$, $^4A_{2g} \rightarrow {}^4T_{1g}(P)$ and $^4A_{2g} \rightarrow {}^4T_{2g}$

(d) $^4A_{2g} \rightarrow {}^4T_{1g}$, $^4A_{2g} \rightarrow {}^4T_{1g}(F)$ and $^4A_{2g} \rightarrow {}^4T_{1g}(P)$

GATE 2017

61. The electronic ground state term for the chromium ion in $\left[Cr(CN)_6\right]^{4-}$ is

(a) ^3F (b) ^3H (c) ^3G (d) ^5D

62. The VO_4^{3-}, CrO_4^{2-} and MnO_4^- ion exhibit intense ligand to metal charge transfer transition. The wavelengths of this transition follow the order

(a) $CrO_4^{2-} < VO_4^{3-} < MnO_4^-$

(b) $MnO_4^- < VO_4^{3-} < CrO_4^{2-}$

(c) $VO_4^{3-} < CrO_4^{2-} < MnO_4^-$

(d) $CrO_4^{2-} < MnO_4^{-2} < VO_4^{3-}$

63. If Δ_o is the octahedral splitting energy and P is the electron pairing energy, then the crystal – field stabilization energy (CFSE) of $\left[Co(NH_3)_6\right]^{2+}$ is

(a) $-0.8\Delta_o + 2P$ (b) $-0.8\Delta_o + 1P$ (c) $-0.8\Delta_o$ (d) $-1.8\Delta_o + 3P$

64. The spinel structure of $MgAl_2O_4$ has cubic close packed arrangement of oxide ions. The fractions of the octahedral and tetrahedral sites occupied by cations, respectively, are

(a) 1/8 and 1/2 (b) 1/4 and 1/2 (c) 1/2 and 1/4 (d) 1/2 and 1/8

QUANTA CHEMISTRY CLASSES

GATE 2018

65. The water exchange rates for the complex ions follow the order

(a) $\left[V(H_2O)_6\right]^{2+} > \left[Co(H_2O)_6\right]^{2+} > \left[Cr(H_2O)_6\right]^{3+}$

(b) $\left[Cr(H_2O)_6\right]^{3+} > \left[Co(H_2O)_6\right]^{2+} > \left[V(H_2O)_6\right]^{2+}$

(c) $\left[Co(H_2O)_6\right]^{2+} > \left[Cr(H_2O)_6\right]^{3+} > \left[V(H_2O)_6\right]^{2+}$

(d) $\left[Co(H_2O)_6\right]^{2+} > \left[V(H_2O)_6\right]^{2+} > \left[Cr(H_2O)_6\right]^{3+}$

66. The lowest energy $d \rightarrow d$ transition of the complexes follow the order

(a) $\left[Cr(H_2O)_6\right]^{3+} < \left[Cr(NH_3)_6\right]^{3+} < \left[Cr(CN)_6\right]^{3-}$

(b) $\left[Cr(CN)_6\right]^{3-} < \left[Cr(NH_3)_6\right]^{3+} < \left[Cr(H_2O)_6\right]^{3+}$

(c) $\left[Cr(CN)_6\right]^{3-} < \left[Cr(H_2O)_6\right]^{3+} < \left[Cr(NH_3)_6\right]^{3+}$

(d) $\left[Cr(NH_3)_6\right]^{3+} < \left[Cr(CN)_6\right]^{3-} < \left[Cr(H_2O)_6\right]^{3+}$

67. The symmetry label of valence p orbitals of a metal ion in an octahedral ligand field is

(a) t_{lg} (b) t_{tu} (c) $e_g + a_{lg}$ (d) t_{2g}

68. Spectroscopic ground state term symbols of cobalt ions in $\left[Co(H_2O)_6\right]^{2+}$ and $\left[CoCl_4\right]^{2-}$ respectively are

(a) $^2T_{lg}$ and $^4A_2$ (b) $^4T_{lg}$ and $^4A_2$ (c) $^4T_{2g}$ and ^4T_l (d) ^2T_l and ^4A_l

69. For an inverse spinel, AB_2O_4, the A and B, respectively, can be

(a) Ni(II) and Ga(III) (b) Zn(II) and Fe(III)

(c) Fe(II) and Cr(III) (d) Mn(II) and Mn(III)

GATE 2019

70. The Δ_0 value of $[Ni(H_2O)_6]^{2+}$ is 8500 cm^{-1}. The Δ_0 values for $[NiCl_6]^{4-}$ and $[Ni(NH_3)_6]^{2+}$ compared to $[Ni(H_2O)_6]^{2+}$ are

(a) higher and lower, respectively (b) lower and higher, respectively

(c) higher in both complex ions (d) lower in both complex ions.

71. The experimentally observed magnetic moment value, which match well with the spin-only values for the pair of aqueous ions is

(Atomic number: Cr = 24, Co = 27, Gd = 64, Tb = 65, Dy = 66 and Lu = 71)

(a) Cr(III) and Gd(III) (b) Co(II) and Gd(III)

QUANTA CHEMISTRY CLASSES

(c) Cr(III) and Dy(III) (d) Lu(III) and Tb(III)

72. A complex is composed of one chromium ion, three bromides and six water molecules. Upon addition of excess $AgNO_3$, 1.0 g aqueous solution of the complex gave 0.94 g of AgBr. The molecular formula of the complex is

(Atomic weight: Cr = 52, Br = 80, Ag = 108, O = 16 and H = 1)

(a) $[Cr(H_2O)_6]Br_3$ (b) $[Cr(H_2O)_5Br]Br_2 \cdot H_2O$

(c) $[Cr(H_2O)_4Br_2]Br \cdot 2H_2O$ (d) $[Cr(H_2O)_3Br_3] \cdot 3H_2O$

73. The rate of the following redox reaction is slowest when X is

$$[Co^{III}(NH_3)_5X]^{3+/2+} + [Cr^{II}(H_2O)_6]^{2+} \rightarrow [Co^{II}(NH_3)_5(H_2O)]^{2+} + [Cr^{III}(H_2O)_5X]^{3+/2+}$$

(a) H_2O (b) NH_3 (c) Cl^- (d) N_3^-

74. Among the following compounds, a normal spinel is

(a) $MgFe_2O_4$ (b) $ZnFe_2O_4$ (c) $CoFe_2O_4$ (d) $CuFe_2O_4$

GATE 2020

75. The maximum numbewr of microstates for d^2 electronic configuration is _____

76. In the electronic absorption spectrum of an aqueous solution of $[Ni(NH_3)_6]^{2+}$, a very weak band is observed between the bands due to the transitions $^3A_{2g} \rightarrow {}^3T_{2g} \rightarrow$ and $^3A_{2g} \rightarrow {}^3T_{1g}(F)$. The transition responsible for the very weak band is

(Given: atomic number of Ni is 28)

(a) $^3A_{2g} \rightarrow {}^1T_{1g}$ (b) $^3A_{2g} \rightarrow {}^1E_g$ (c) $^3A_{2g} \rightarrow {}^1T_{2g}$ (d) $^3A_{2g} \rightarrow {}^1A_{2g}$

GATE 2021

77. The reaction of $NiBr_2$ with two equivalents of PPh_3 in CS_2 at –78ºC gives a red-colored diamagnetic complex. $[NiBr_2(PPh_3)_2]$. This transforms to a green-colored paramagnetic complex with the same molecular formula at 25ºC. The geometry and the number of unpaired electrons in the green-colored complex, respectively, are:

(a) square planar and 2

(b) tetrahedral and 2

(c) square planar and 4

(d) tetrahedral and 1

78. The rate of the substitution reaction of $[Co(CN)_5Cl]^{3-}$ with OH^- to give $[Co(CN)_5(OH)]^{3-}$

(a) is inversely proportional to the concentration of OH^-

(b) depends on the concentrations of both $[Co(CN)_5Cl]^{3-}$ and OH^-

(c) depends on the concentration of $[Co(CN)_5Cl]^{3-}$ only

(d) is directly proportional to the concentration of OH^- only

79. The yellow color of an aqueous solution of K_2CrO_4 changes to red-orange upon the addition of a few drops of HCl. The red-orange complex, the oxidation state of its central element(s), and the origin of its color, respectively, are:

(a) perchlorate ion, +7, charge transfer

(b) chromium chloride, +3, d-d transition

(c) dichromate ion, +6 and +6, charge transfer

(d) chromic acid, +6, charge transfer

80. The Δ_0 of

$[Cr(H_2O)_6]^{3+}$, $[CrF_6]^{3-}$ and $[Cr(CN)_6^{3-}$

follows the order:

(a) $[CrF_6]^{3-} > [Cr(CN)_6]^{3-} > [Cr(H_2O)_6]^{3+}$ (b) $[Cr(H_2O)_6]^{3+} > [CrF_6]^{3-} > [Cr(CN)_6]^{3-}$

(c) $[CrF_6]^{3-} > [Cr(H_2O)_6]^{3+} > [Cr(CN)_6]^{3-}$ (d) $[Cr(CN)_6]^{3-} > [Cr(H_2O)_6]^{3+} > [CrF_6]^{3-}$

81. The spin-only magnetic moment of $[Co(H_2O)_6]^{2+}$ (rounded off to one decimal place) is _____BM.

82. The correct order of increasing intensity (molar absorptivity) of the UV-visible absorption bands for the ions $[Ti(H_2O)_6]^{3+}$, $[Mn(H_2O)_6]^{2+}$, $[CrO_4]^{2-}$, and $[NiCl_4]^{2-}$ is

(a) $[Ti(H_2O)_6]^{3+} < [NiCl_4]^{2-} < [CrO_4]^{2-} < [Mn(H_2O)_6]^{2+}$

(b) $[Ti(H_2O)_6]^{3+} < [Mn(H_2O)_6]^{2+} < [CrO_4]^{2-} < [NiCl_4]^{2-}$

(c) $[Mn(H_2O)_6]^{2+} < [Ti(H_2O)_6]^{3+} < [NiCl_4]^{2-} < [CrO_4]^{2-}$

(d) $[NiCl_4]^{2-} < [Ti(H_2O)_6]^{3+} < [Mn(H_2O)_6]^{2+} < [CrO_4]^{2-}$

QUANTA CHEMISTRY CLASSES

COORDINATION

ANSWERS KEY

1.	(a)	2.	(d)	3.	(a)	4.	(d)	5.	(b)	6.	(b)	7.	(d)
8.	(c)	9.	(c)	10.	(a)	11.	(b)	12.	(c)	13.	(b)	14.	(a)
15.	(c)	16.	(d)	17.	(d)	18.	(a)	19.	(d)	20	(b)	21.	(d)
22.	(c)	23.	(b)	24.	(c)	25.	(?)	26.	(b)	27.	(?)	28.	(d)
29.	(b)	30.	(d)	31.	(a)	32.	(c)	33.	(a)	34.	(?)	35.	(?)
36.	(d)	37.	(d)	38.	(b)	39.	(c)	40.	(c)	41.	(b)	42.	(b)
43.	(d)	44.	(c)	45.	(c)	46.	(c)	47.	(c)	48.	(9)	49.	(a)
50.	(b)	51.	(c)	52.	(c)	53.	(a)	54.	(d)	55.	(d)	56.	(c)
57.	(c)	58.	(9)	59.	(2.0)	60.	(d)	61.	(b)	62.	(c)	63.	(c)
64.	(d)	65.	(d)	66.	(a)	67.	(b)	68.	(b)	69.	(a)	70.	(?)
71.	(?)	72.	(?)	73.	(?)	74.	(?)	75.	(2)	76.	(a)	77.	(b)
78.	(c)	79.	(?)	80.	(d)	81.	(3.9)	82.	(c)				

QUANTA CHEMISTRY CLASSES

ORGANOMETALLIC COMPOUNDS

GATE 2005

1. The neutral complex which follows the 18 – electron rule is

(a) $\left(\eta^5-C_5H_5\right)Fe\left(CO_2\right)$ (b) $\left(\eta^5-C_5H_5\right)Mo\left(CO\right)_3$

(c) $\left(\eta^5-C_5H_5\right)_2 CO$ (d) $\left(\eta^5-C_5H_5\right)Re\left(\eta^6-C_6H_6\right)$

2. For the metal – olefin complexes (i) $\left[PtCl_3\left(C_2H_4\right)\right]^-$ and (ii) $\left[PtCl_3\left(C_2F_4\right)\right]^-$, the correct statement is that

(a) carbon – carbon bond length is same both in (i) and (ii)

(b) carbon – carbon bond legnth in (i) is smaller compared to that of (ii)

(c) carbon – carbon bond length in (i) is larger compared to that of (ii)

(d) a metallacycle is formed in each complex

3. The value of M – C stretching frequencies of (i) $\left[V\left(CO\right)_6\right]^-$, (ii) $\left[Cr\left(CO\right)_6\right]$ and (iii) $\left[Mn\left(CO\right)_6\right]^+$ following the trend

(a) (ii) > (i) > (iii) (b) (ii) > (iii) > (i) (c) (i) > (ii) > (iii) (d) (iii) > (ii) > (i)

4.

Column I	**Column II**
P: Wilkinson's catalyst	I. trans – IrCl (CO) $(PPh_3)_2$
Q: Speiers's catalyst	II. Hydrosilylation
R: Water gas shift catalyst	III. RhCl $(PPh_3)_3$
S: Zeolite ZSM – 5 catalyst	IV. Synthetic gasoline
	V. Hydroformlylation
	VI. Zinc – copper oxide

Codes:

(a) P – III, Q – II, R – VI, S – IV (b) P – I, Q – V, R – III, S – IV

(c) S – V, Q – II, R – VI, S – IV (d) P – III, Q – VI, R – IV, S – II

5. **Statement:** The characteristic spectroscopic feature of the quadruply bonded $\left[Re_2\,Cl_8\right]^{2-}$ is a strong royal blue colur

Reason: This is due to an absorption band in the visible region due to excitation of an electron from $\sigma^2\pi^4\delta^2$ ground state ot $\sigma^2\pi^4\delta^1\delta^{*1}$ excited state

Assertion: This transition is quantum mechanically allowed.

QUANTA CHEMISTRY CLASSES

GATE 2006

6. $[Co(CO)_4]$ is isolobal with

(a) CH_4 (b) CH_3 (c) CH_2 (d) CH

7. The CORRECT order of the CO stretching vibrational frequency is

(a) $\left[Ti(CO)_6\right]^{2-} > \left[V(CO)_6\right]^{-} > CO > \left[Cr(CO)_6\right]$

(b) $\left[Cr(CO)_6\right] > CO > \left[V(CO)_6\right]^{-} > \left[Ti(CO)_6\right]^{2-}$

(c) $CO > \left[V(CO)_6\right]^{-} > \left[Ti(CO)_6\right]^{2-} > \left[Cr(CO)_6\right]$

(d) $CO > \left[Cr(CO)_6\right] > \left[V(CO)_6\right]^{-} > \left[Ti(CO)_6\right]^{2-}$

GATE 2007

8. $W(CO)_6$ reacts with MeLi to give an intermediate which upon treatment with CH_2N_2 gives compound X. X is represented as

(a) MWe_6 (b) $(CO)_5$ W– Me

(c) $(CO)_5$ W = C (Me) OMe (d) $(CO)_5$ W ≡ CMe

9. Considering the quadrupolar nature of M – M bond in $\left[Re_2Cl_8\right]^{2-}$, the M – M bond order in $\left[Re_2Cl_4(PMe_2Ph)_4\right]^{+}$ and $\left[Re_2Cl_4(PMe_2Ph)_4\right]$ respectively are

(a) 3.0 and 3.0 (b) 3.0 and 3.5 (c) 3.5 and 3.5 (d) 3.5 and 3.0

10. In the complex, $\left[Ni_2(\eta^5-Cp)_2(CO)_2\right]$, the IR stretching frequency appears at 1857 cm^{-1} (strong) and 1897 cm^{-1} (weak). The valence electron count and the nature of the M-CO bond respectively are

(a) 16 e–, bridging (b) 17 e–, bridging (c) 18 e–, terminal (d) 18 e–, briding

11. The correct classification of $\left[B_5H_5\right]^{2-}$, B_5H_9 and B_5H_{11} respectively is

(a) closo, arachno, nido (b) arachno, closo, nido

(c) closo, nido, arachno (d) nido, arachno, closo

12. In the reaction shown bnelow, X and Y respectively are

$$Mn_2(CO)_{10} \xrightarrow{Na} (X) \xrightarrow{CH_3COCl} (Y)$$

(a) $\left[Mn(CO)_4\right]^{2-}, \left[CH_3C(O)Mn(CO)_5\right]^{-}$ (b) $\left[Mn(CO)_4\right]^{2-}, \left[CH_3C(O)Mn(CO)_5\right]$

(c) $\left[Mn(CO)_5\right]^{-}, \left[ClMn(CO)_5\right]$ (d) $\left[Mn(CO)_5\right]^{2-}, \left[ClMn(CO)_5\right]^{-}$

13. The catalyst used in the conversion of ethylene to acetaldehyde using Wacker process is

(a) $HCo(CO_4)$ (b) $\left[PdCl_4\right]^{2-}$

(c) V_2O_5 (d) $TiCl_4$ in the presence of $Al(C_2H_5)_3$

QUANTA CHEMISTRY CLASSES

14. Zeise's salt is represented as

(a) H_2PtCl_6 (b) $[PtCl_4]^{2-}$ (c) $[ZnCl_4]^{2-}$ (d) $\left[PtCl_3\left(\eta^2-C_2H_4\right)\right]^-$

GATE 2008

15. Metal – metal quadruple bonds are well – known for the metal

(a) Ni (b) Co (c) Fe (d) Re

16. The Bronsted acidity of boron hydrides follows the order

(a) $B_2H_6 > B_4H_{10} > B_5H_9 > B_{10}H_{14}$ (b) $B_2H_6 = B_4H_{10} > B_5H_9 = B_{10}H_{14}$

(c) $B_{10}H_{14} > B_5H_9 > B_4H_{10} > B_2H_6$ (d) $B_5H_9 > B_4H_{10} > B_2H_6 > B_{10}H_{14}$

17. White phosphorus, P_4, belongs to the

(a) closo system (b) nodo system (c) arachno system (d) hypho system

18. The number of M – M bonds in $Ir_4(CO)_{12}$ are

(a) four (b) six (c) eight (d) zero

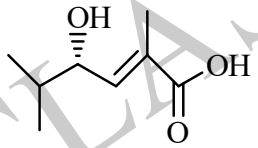
19. Schrock carbenes are

(a) Triplets and nucleophilic (b) Triplets and electrophilic

(c) Singlets and nucleophilic (d) Singlets and electrophilic

GATE 2009

20. For the compound



the stereochemical notations are

(a) 2Z, 4R (b) 2Z, 4S (c) 2E, 4R (d) 2E, 4S

21. The correct order of ν_{co} for the compounds $\left[Mo(CO)_3(NMe_3)_3\right]$, $\left[Mo(CO)_3\left(P(OPh)_3\right)_3\right]$, $\left[Mo(CO)_3(PMe)_3\right]$, $\left[Mo(CO)_3(PCl_3)_3\right]$ in the IR spectrum is:

(a) $\left[Mo(CO)_3(NMe_3)_3\right] > \left[Mo(CO)_3\left(P(OPh)_3\right)_3\right] > \left[Mo(CO)_3(PMe_3)_3\right] > \left[Mo(CO)_3(PCl_3)_3\right]$

(b) $\left[Mo(CO)_3(PCl_3)_3\right] > \left[Mo(CO)_3(NMe_3)_3\right] > \left[Mo(CO)_3\left(P(OPh)_3\right)_3\right] > \left[Mo(CO)_3(PMe_3)_3\right]$

(c) $\left[Mo(CO)_3(PCl_3)_3\right] > \left[Mo(CO)_3\left(P(OPh)_3\right)_3\right] > \left[Mo(CO)_3(PMe_3)_3\right] > \left[Mo(CO)_3(NMe_3)_3\right]$

(d) $\left[Mo(CO)_3(PMe_3)_3\right] > \left[Mo(CO)_3(NMe_3)_3\right] > \left[Mo(CO)_3(PCl_3)_3\right] > \left[Mo(CO)_3\left(P(OPh)_3\right)_3\right]$

QUANTA CHEMISTRY CLASSES

22. In the reaction, $Ph_3P \xrightarrow{MeI} [X] \xrightarrow{n-BuLi} [Y]$, the compounds X and Y, respectively are

(a) $[Ph_3P(Me)I]; Ph_3P = CH - CH_2 - CH_3$

(b) $[Ph_3P(Me)][I]; Ph_3P = CH_2$

(c) $[Ph_3P(Me)_2]; Ph_3P = CH_2$

(d) $[Ph_3P(Me)][I]; Ph_3P$

23. The compounds M and N, respectively, are

(a) $[(C_5H_5)W(CO)_3]Na$ and $[(C_5H_5)W(CO)_3H]$

(b) $[(C_5H_5)W(CO)_4]Na$ and $[(C_5H_5)W(CO)_4H]$

(c) $[(C_5H_5)W(CO)_3]Na$ and $[(C_5H_5)W(CO)_4H]$

(d) $[(C_5H_5)W(CO)_4]Na$ and $[(C_5H_5)W(CO)_3H]$

24. The compounds O and P, respectively, are

(a) $[(C_5H_5)W(CO)_3]_2$ and $[(C_5H_5)W(CO)_3Br]$

(b) $[(C_5H_5)W(CO)_4]$ and $[(C_5H_5)W(CO)_2Br(THF)]$

(c) $[(C_5H_5)W(CO)_2(THF)_2]$ and $[(C_5H_5)W(CO)_3Br]$

(d) $[(C_5H_5)W(CO)_3]_2$ and $[(C_5H_5)W(CO)_2Br(THF)]$

GATE 2010

25. The number of 'framework electron pairs' present in the borane cluster $[B_{12}H_{12}]^{2-}$ is:

(a) 10 (b) 11 (c) 12 (d) 13

26. The reaction between $\{PdCl_4]^{2-}$ and C_2H_4 produces a new compound. Compare to free C_2H_4, the C – C bond order of the product is:

(a) between 1 and 2 (b) less than 1

(c) unaltered (d) greater than 2

27. Structurally nickellocene is similar to ferrocene. Nickellocene attains stability due to the formation of

(a) a monocation

(b) a dication

(c) a monoanion

(d) a dianion

QUANTA CHEMISTRY CLASSES

GATE 2011

28. The total number of metal-metal bonds in $Ru_3(CO)_{12}$ and $Co_4(CO)_{12}$, respectively, is

(a) 3 and 6 (b) 4 and 5 (c) zero and 4 (d) 3 and 4

29. The product of the reaction between $CH_3Mn(CO)_5$ and ^{13}CO is:

(a) $(CH_3\ ^{13}CO)Mn(CO)_5$ (b) $(CH_3CO)Mn(CO)_4(^{13}CO)$

(c) $(^{13}CH_3CO)Mn(CO)_5$ (d) $CH_3Mn(CO)_4$

GATE 2012

30. The number of terminal carbonyl groups present in $Fe_2(CO)_9$ is

(a) 2 (b) 5 (c) 6 (d) 3

31. An intermediate formed during the hydroformylationof olefins using $Co_2(CO)_8$ as catalyst is

(a) $HCo(CO)_6$ (b) $H_4Co(CO)_3$ (c) $H_2Co(CO)_4$ (d) $HCo(CO)_4$

GATE 2013

32. Decarbonylation reaction of [cis – (CH_3CO) Mn $(^{13}CO)(CO)_4$] yields X, Y and Z, where X = [(CH_3) Mn $(CO)_5$]; Y = [cis – (CH_3) Mn (^{13}CO) CO_4]; [Z = trans – (CH_3) Mn (^{13}CO) $(CO)_4$]

The molar ratio of the products (X : Y : Z) in this reaction is

(a) 1 : 1 : 1 (b) 1 : 2 : 1 (c) 1 : 1 : 2 (d) 2 : 1 : 1

33. According to polyhedral electron count rule, the structure of $Rh_6(CO)_{16}$ is:

(a) closo (b) nido (c) arachno (d) hypho

GATE 2014

34. An example of nido-borane from the following is

(a) B_4H_{10} (b) B_6H_{10} (c) B_6H_{12} (d) B_8H_{14}

35. The reaction of $[Cp_2TaMe_2]I$ ($Cp = C_5H_5^-$) with NaOMe yields.

(a) $[Cp_2Ta(OMe)_2]I$ (b) $[Cp_2Ta(Me)OMe]I$ (c) $Cp_2Ta(Me) = CH_2$ (d) $Cp_2Ta(OMe) = CH_2$

36. Amonst the following, the metal carbonyl species having the highest ν_{CO} stretching frequency is

(a) $[Mn(CO0_6]^+$ (b) $Cr(CO)_6$ (c) $[V(CO)_6]^-$ (d) $[Fe(CO)_4]^{2-}$

37. The correct order of thermal stability for the given compounds is

(a) $TiMe_4 > Ti(CH_2CMe_3)_4 > TiEt_4$ (b) $TiEt_4 > Ti(CH_2CMe_3)_4 > TiMe_4$

(c) $TiMe_4 > TiEt_4 > Ti(CH_2CMe_3)_4$ (d) $Ti(CH_2CMe_3)_4 > TiMe_4 > TiEt_4$

38. In Monsanto acetic acid process shown below, the role of HI is

$$CH_3OH + CO \xrightarrow[180^oC,\ 30\ bar]{Rh(\ell)\text{catalyst/HI}} CH_3CO_2H$$

(a) to convert CH_3OH to a stronger nucleophile (CH_3O^-)

(b) to reduce the Rh(I) catalyst to a Rh(0) species

(c) to reduce a Rh(III) active species to a Rh(I) species in the catalytic cycle

(d) to convert CH_3OH to CH_3I

GATE 2015

39. An efficient catalyst for hdrogenation of alkenes is $\left[Rh\left(PPh_3\right)_3Cl\right]$. However, $\left[Ir\left(PPh_3\right)_3Cl\right]$ does not catalyze this reaction, because

(a) PPh_3 binds stronger to Ir than to Rh (b) Cl binds stronger to Ir than to Rh

(c) PPh_3 binds stronger to Rh than to Ir (d) Cl binds stronger to Rh than to Ir

40. When one CO group is replaced by PPh_3 in $[Cr(CO)_6]$, which one of the following statement is TRUE?

(a) The Cr-C bond length increases and CO bond length decreases

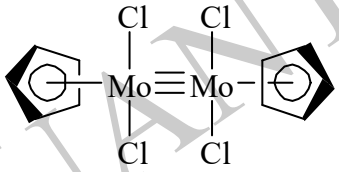
(b) The Cr-C bond length decreases and CO bond length decreases

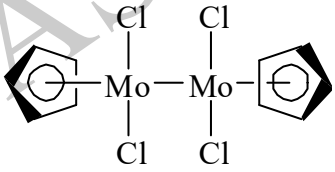
(c) The Cr-C bond length decreases and CO bond length increases

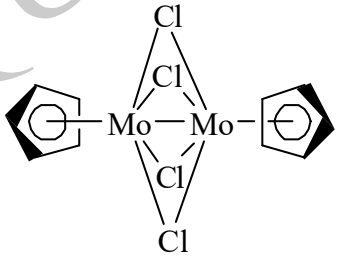
(d) The Cr-C bond length increases and CO bond length increases

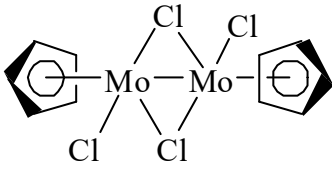
GATE 2016

41. $[CpMoCl_2]_2$ obeys the 18 electron rule. The correct structure of this compound is (atomic number of Mo = 42)

(a) 

(b) 

(c) 

(d) 

42. Among the given boranes and heteroboranes, the example which belongs to 'closo' type is

(a) $B_5H_8^-$ (b) $\left[C_2B_9H_{11}\right]^{2-}$ (c) $GeC_2B_9H_{11}$ (d) B_6H_{10}

QUANTA CHEMISTRY CLASSES

GATE 2017

43. The hapticity of cycloheptatriene, (C_7H_8), in $Mo(C_7H_8)(CO)_3$ is _____

44. The structure type and shape of the polyhedral (skeletal) framework of the carborane $Me_2C_2B_{10}H_{10}$, respectively, are

(a) nido and dodecahedron (b) closo and icosahedron

(c) nido and icosahedron (d) closo and dodecahedron

GATE 2018

45. Based on Wade's rule, the structure-type of $[B_5H_8]^-$ is

(a) closo (b) nido (c) arachno (d) hypho

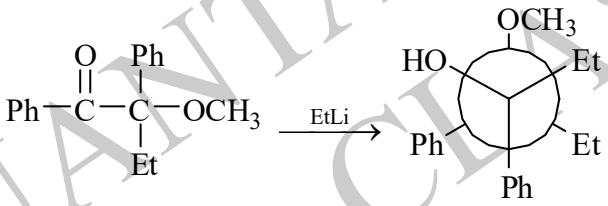
46. The reaction of equimolar quantities of $Fe(CO)_5$ and OH^- gives a complex species X which on further reaction with MnO_2 give species Y. X and Y, respectively, are

(a) $\left[Fe(CO)_5(OH)\right]^-$ and $Fe_2(CO)_9$ (b) $\left[Fe(CO)_4\right]^{2-}$ and $Mn_2(CO)_{10}$

(c) $\left[HFe(CO)_4\right]^-$ and Fe_2O_3 (d) $\left[HFe(CO)_4\right]^-$ and $Fe_3(CO)_{12}$

GATE 2019

47. In the following reaction, the stereochemistry of the major product is predicted by the



(a) Cram's model (b) Cram's chelation model

(c) Felkin model (d) Felkin-Anh model

48. The product obained in the reaction of $Mn_2(CO)_{10}$ with Br_2 is

(a) $Mn(CO)_5Br$ (b) $Mn_2(CO)_8Br_2$ (c) $Mn(CO)_4Br_2$ (d) $Mn_2(CO)_9Br$

49. The correct molecular representation of $W(Cp)_2(CO)_2$ is

(Cp = cyclopentadienyl)

(a) $[W(\eta^1-Cp)(\eta^3-Cp)(CO)_2]$

(b) $[W(\eta^1-Cp)(\eta^5-Cp)(CO)_2]$

(c) $[W(\eta^3-Cp)(\eta^5-Cp)(CO)_2]$

(d) $[W(\eta^5-Cp)_2(CO)_2]$

QUANTA CHEMISTRY CLASSES

GATE 2020

50. The CORRECT statement regarding the substitution of coordinated ligands in $Ni(CO)_4$ and $Co(NO)(CO)_3$ is:

(Given: Co–N–O bond is nearly linear; atomic numbers of Co and Ni are 27 and 28, respectively)

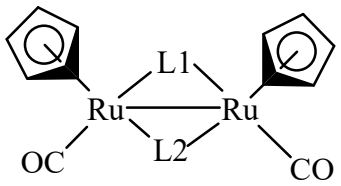
(a) $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow associative and dissociative pathways, respectively.

(b) Both $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow associative pathway.

(c) Both $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow dissociative pathway.

(d) $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow dissociative and associative pathways, respectively.

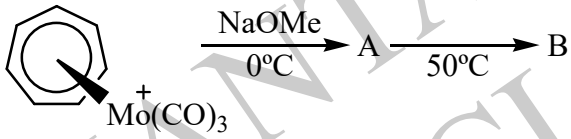
51. The CORRECT combination of L1 and L2 among H^-, NO^-, $MeCH^{2-}$ and CO, that will satisfy the 18 electron rule for both metal centers in the following neutral molecule, is



(Given: atomic number of Ru is 44)

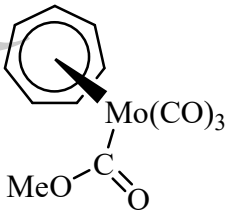
(a) H^-, NO^- (b) H^-, CO (c) $MeCH^{2-}$, CO (d) $MeCH^{2-}$, NO^-

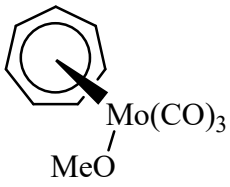
52. In the following reaction sequence,

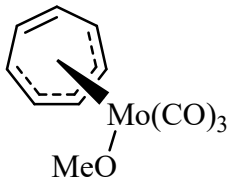


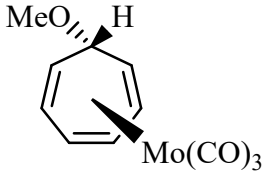
the structure of B is

(Given: atomic number of Mo is 42)

(a) 

(b) 

(c) 

(d) 

53. Among the following,

$[B_{12}H_{12}]^{2-}$, $[Ni_5(CO)_{12}]^{2-}$, $[C_2B_9H_{11}]^{2-}$, $Rh_6(CO)_{16}$, $Os_6(CO)_{20}$, B_5H_{11}, B_6H_{10}

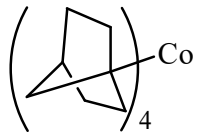
the total number of species having nido structure is _____

(Given: atomic numbers of H, B, C, O, Ni, Rh and Os are 1, 5, 6, 8, 28, 45 and 76 respectively)

QUANTA CHEMISTRY CLASSES

GATE 2021

54. The geometry and the number of unpaired electrons in tetrakis (1 – norbornyl)Co



respectively, are:

(a) tetrahedral and five (b) square planar and three

(c) tetrahedral and one (d) square planar and one

55. The metal borides that contain isolated boron atoms are:

(a) Ti_4B_4 and V_3B_4 (b) TiB and HfB (c) Tc_7B_3 and Re_7B_3 (d) Cr_5B_3 and V_3B_2

56. The Mo–Mo bond order in $[(\eta^5\text{-}C_5H_5)Mo(CO)_2]_2$ which obeys the 18-electron rule is _____.

QUANTA CHEMISTRY CLASSES

ORGANOMETALLIC COMPOUNDS

ANSWER KEY

1.	(d)	2.	(b)	3.	(c)	4.	(a)	5.	(a)	6.	(b)	7.	(d)
8.	(c)	9.	(d)	10.	(c)	11.	(c)	12.	(b)	13.	(b)	14.	(d)
15.	(d)	16.	(c)	17.	(b)	18.	(b)	19.	(a)	20	(d)	21.	(c)
22.	(b)	23.	(a)	24.	(a)	25.	(c)	26.	(a)	27.	(b)	28.	(a)
29.	(b)	30.	(a)	31.	(b)	32.	(b)	33.	(a)	34.	(b)	35.	(c)
36.	(a)	37.	(d)	38.	(d)	39.	(a)	40.	(c)	41.	(c)	42.	(c)
43.	(a)	44.	(b)	45.	(b)	46.	(d)	47.	(*)	48.	(a)	49.	(c)
50.	(b)	51.	(c)	52.	(d)	53.	(3)	54.	(c)	55.	(c)	56.	(3)

QUANTA CHEMISTRY CLASSES

MAIN GROUP ELEMENT

GATE 2005

1. Triplet superphosphate is made by treating phosphate rock with
   (a) conc. H_2SO_4 (b) conc. HNO_3 (c) conc. HCl (d) conc. H_3PO_4
2. The number of hydroxy (OH) groups present in phosphorus acid is
   (a) one (b) two (c) three (d) four
3. Among the following, the incorrect statement about SiC is that
   (a) it is known as corundum
   (b) it is prepared by reducing quartz with a slight excess of coke in an electric furnace at 2000 – 2500^{0}C
   (c) pure SiC is almost colourless or pale yellow
   (d) its hardness is slightly less than diamond.
4. The incorrect statement regarding carboranes is that
   (a) carbon tends to adopt the position of the lowest coordination number on the polyhedron
   (b) CH groups tend to be more positive than BH groups with the same coordination number
   (c) carbon tends to keep as close as possible to other carbon atoms
   (d) generally, arachno – carboranes are less stable thermally than the corresponding closo – carboranes

GATE 2006

5. $Mg_6Si_4O_{10}(OH)_8$ is commercially known as
   (a) asbestos (b) water-glass (c) soda-glass (d) zeolite
6. The series with the orrect order of decreasing ionic size is
   (a) $K^+ > Ca^{2+} > S^{2-} > Cl^-$
   (b) $S^{2-} > Cl^- > K^+ > Ca^{2+}$
   (c) $K^+ > Cl^- > Ca^{2+} > S^{2-}$
   (d) $Cl^- > K^+ > S^{2-} > Ca^{2+}$
7. When Al_4C_3 and Mg_2C_3 reacts with H_2O, then major products formed respectively, are
   (a) ethyne and ethane
   (b) methane and propyne
   (c) propane and propene
   (d) methane and propene

QUANTA CHEMISTRY CLASSES

GATE 2007

8. Boric acid in aqueous solution in presence of glycerol behaves as a strong acid due to the formation of

(a) an anionioc metal – chelate (b) borate anion

(c) glycerate ion (d) a charge transfer complex

9. The compounds X and Y in the following reactio are

$$P_4S_{10} \xrightarrow{EtOH} (X) \xrightarrow{Cl_2} (Y) \xrightarrow{p\text{–}O_2NC_6H_4ONa} \text{Parathion}$$

(a) $X = (Et)_2P(S)SH$; $Y = (Et)_2P(S)Cl$ (b) $X = (EtO)_2P(S)SH$; $Y = (EtO)_2P(S)Cl$

(c) $X = (EtO)_2PSH$; $Y = (EtO)_2PCl$ (d) $X = (Et)_3PO$; $Y = (Et)_3PCl$

10. The Lewis acid character of BF_3, BCl_3 and BBr_3 follows the order

(a) $BF_3 < BBr_3 < BCl_3$ (b) $BCl_3 < BBr_3 < BF_3$

(c) $BF_3 < BCl_3 < BBr_3$ (d) $BBr_3 < BCl_3 < BF_3$

GATE 2008

11. The reaction of Al_4C_3 with water leads to the formation of

(a) methane (b) propyne (c) propene (d) propane

12. The correct statement about C_{60} is

(a) C_{60} is soluble in benzene

(b) C_{60} does not react with tert – butyllithium

(c) C_{60} is made up of 10 five – membered and 15 six – membered rings

(d) two adjacent five – membered rings share a common edge.

13. The INCORECT statement about linear dimethylopolysiloxane, $\left[(CH_3)_2SiO\right]_n$, is

(a) it is extremely hydrophilic

(b) it is prepared by a KOH catalysed ring – opening reaction of $[Me_2SiO]_4$

(c) it has a very low glass transition temperature

(d) it can be reinforced to give silicon elastomers

GATE 2009

14. The reaction of phosgene with an excess of NH_3 produces

(a) $HN = C = O$ (b) $H_2N - C(Cl) = O$ (c) $(H_2N)_2C = O$ (d) $(H_2N)_2CCl_2$

15. The coordination number of the Ba^{2+} ions in barium fluoride is 8. The coordination number of the fluorie ion is:

(a) 8 (b) 4 (c) 1 (d) 2.

16. In the reaction $HSO_4^-(aq) + OH^-(aq) \rightleftharpoons SO_4^{2-}(aq) + H_2O(\ell)$, the conjugate acid-base pairs are

(a) HSO_4^- and SO_4^{2-} ; H_2O and OH^- (b) HSO_4^- and H_3O^+; SO_4^{2-} and OH^-

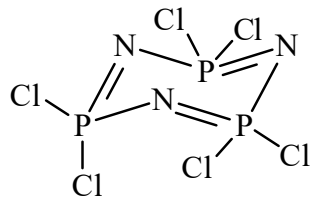
(c) HSO_4^- and OH^- ; SO_4^{2-} ; H_2O (d) HSO_4^- and OH^- ; SO_4^{2-} and H_3O^+

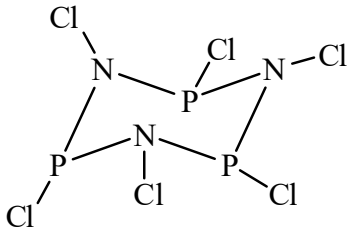
QUANTA CHEMISTRY CLASSES

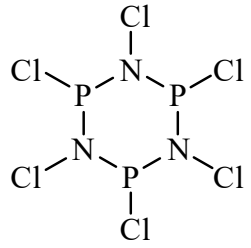
17. The reaction X and Y, respectively, are

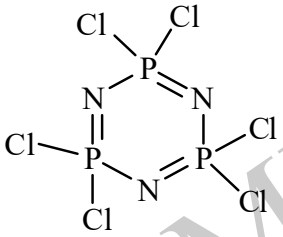
(a) PCl_3 ; NH_3 (b) PCl_5 ; NH_3 (c) PCl_5 ; NH_3Cl (d) PCl_3 ; NH_4Cl

18. The structure of triphosphazene is

(a) 

(b) 

(c) 

(d) 

Statement for Linked Q. 59 and Q. 60:

In the reaction mechanism given, $X + Y \underset{k_2, E_{A,2}}{\overset{k_1, E_{A,1}}{\rightleftharpoons}} Z \xrightarrow{k_3, E_{A,3}} P$

'k' s represent rate constants, 'E_A's represent activation energies, and $k_2 >> k_3$

GATE 2010

19. The Lewis acidity of BF_3 is less than CBl_3 even though fluorine is more electronegative than chlorine. It is due to

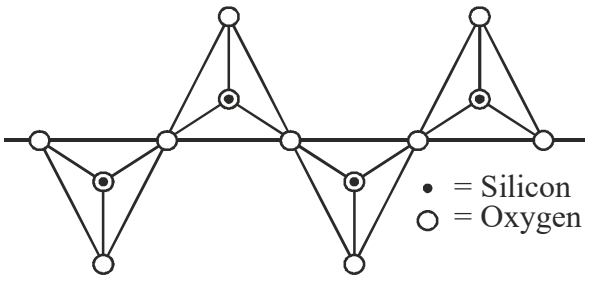
(a) stronger 2p (B) – 2p (F) σ – bonding

(b) stronger 2p (B) – 2p (F) π – bonding

(c) stronger 2p (B) – 2p (Cl) σ – bonding

(d) stronger 2p (B) – 2p (Cl) π – bonding

20. Pyrozenes are a class of silicate minerals, which exhibit a polymeric chain structure, as shown below



Its simplest repeat unit is

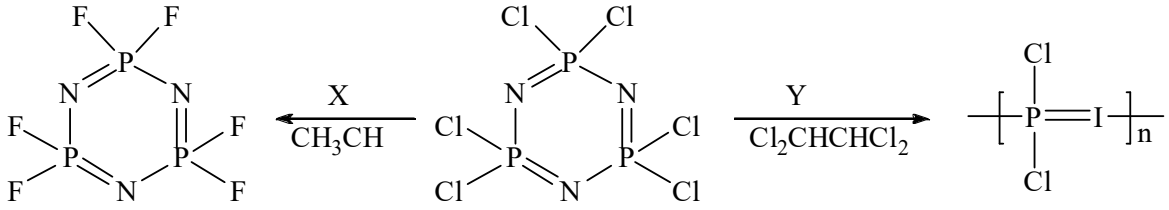
(a) $[SiO_4]^{4-}$ (b) $[SiO_3]^{2-}$ (c) $[Si_2O_7]^{6-}$ (d) $[Si_4O_{11}]^{6-}$

QUANTA CHEMISTRY CLASSES

21. Among the following pentachlorides the one which does not exist due to the 'inertpair effeect' is

(a) PCl_5 (b) $BiCl_5$ (c) $SbCl_5$ (d) $AsCl_5$

22. In the following reactions:



the reagent / conditions X and Y are

(a) X = BF_3; Y = heating at 1250ºC (b) X = NaF; Y = heating at 25ºC

(c) X = NH_4F; Y = HCl (d) X = CF_3SO_3H; Y = H_2SO_4

GATE 2011

23. Among the following, the group of molecules that undergoes rapid hydrolysis is:

(a) $SF_6, Al_2Cl_6, SiMe_4$ (b) $BCl_3, SF_6, SiCl_4$ (c) $[XeF]^+[AsF_6]^-$ (d) $[Xe_2F_3]^+[AsF_6]^-$

24. The reaction of solid XeF_2 with AsF_5 in 1:1 ratio affords

(a) XeF_4 and AsF_3 (b) XeF_6 and AsF_3 (c) $[XeF]^+[AsF_6]^-$ (d) $[Xe_2F_3]^+[AsF_6]^-$

25. For Et_2AlX (X = PPh_2^-, Ph^-, Cl^{-1} and H^-), the tendency towards dimeric structure follows the order

(a) $PPh_2^- > Cl^- > H^- > Ph^-$ (b) $Cl^- > PPh_2^- > H^- > Ph^-$

(c) $Ph^- > H^- > Cl^- > PPh_2^-$ (d) $H^- > Ph^- > PPh_2^- > Cl^-$

26. The ideal molar ratio of Na_2HPO_4 to NaH_2PO_4 is:

(a) 4 : 1 (b) 1 : 4 (c) 3 : 2 (d) 2 : 3

27. The total charge on pentaphosphate anion is:

(a) –5 (b) –3 (c) –7 (d) –9

GATE 2012

28. The enthalpies of hydration of Ca^{2+}, Mn^{2+} and Zn^{2+} follow the order

(a) $Mn^{2+} > Ca^{2+} > Zn^{2+}$ (b) $Zn^{2+} > Ca^{2+} > Mn^{2+}$

(c) $Mn^{2+} > Zn^{2+} > Ca^{2+}$ (d) $Zn^{2+} > Mn^{2+} > Ca^{2+}$

29. Among the following substituted silanes, the one that gives cross – linked silicone polymer upon hydrolysis is

(a) $(CH_3)_4Si$ (b) CH_3SiCl_3 (c) $(CH_3)_2SiCl_2$ (d) $(CH_3)_3SiCl$

30. Among the following donors, the one that forms most stable adduct with the Lewis acid $B(CH_3)_3$ is:

(a) 4 – methylpyridine (b) 2, 6 – dimethylpyridine

(c) 4 – nitropyridine (d) 2, 6 – di – tert – butylpyridine

31. The order of polarity of NH_3, NF_3 and BF_3 is:

(a) $NH_3 < NF_3 < BF_3$ (b) $BF_3 < NF_3 < NH_3$

(c) $BF_3 < NH_3 < NF_3$ (d) $NF_3 < BF_3 < NH_3$

QUANTA CHEMISTRY CLASSES

32. If a mixture of NaCl, conc. H_2SO_4 and $K_2Cr_2O_7$ is heated in a dry test tube, a red vapour (P) is formed. This vapour (P) dissolves in aqueous NaOH to form a yellow solution, which upon treatment with $AgNO_3$ forms a red solid (Q). P and are, respectively

(a) CrO_2Cl_2 and $Ag_2Cr_2O_7$ (b) $Na_2[CrOCl_5]$ and Ag_2CrO_4

(c) $Na_2[CrOCl_5]$ and $Ag_2Cr_2O_7$ (d) CrO_2Cl_2 and Ag_2CrO_4

GATE 2013

33. The increasing order of melting points of the halides NaCl, CuCl and NaF is:

(a) CuCl < NaCl < NaF (b) NaF < NaCl < CuCl

(c) NaF < CuCl < NaCl (d) CuCl < NaF < NaCl

GATE 2014

34. The number of S–S bonds in $H_2S_5O_6$ is _____

35. BCl_3 and NH_4Cl were heated at 140ºC to give compound X, which when treated with $NaBH_4$ gave another compound Y. Compounds X and Y are

(a) $X = B_3N_3H_3Cl_3$ and $Y = B_3N_3H_6$ (b) $X = B_3N_3H_9Cl_3$ and $Y = B_3N_3H_6$

(c) $X = B_3N_3H_3Cl_3$ and $Y = B_3N_3H_{12}$ (d) $X = B_3N_3Cl_6$ and $Y = B_3N_3H_6$

GATE 2015

36. The ease of formation of the adduct, $NH_3.BX_3$ (where X = F, Cl, Br) follows the order

(a) $BBr_3 < BVl_3 < BF_3$ (b) $BCl_3 < BF_3 < BBr_3$

(c) $BF_3 < BCl_3 < BBr_3$ (d) $BBr_3 < BF_3 < BCl_3$

37. Ammonolysis of S_2Cl_2 in an inert solvent gives

(a) S_2N_2 (b) S_2N_2Cl (c) $S_2N_2H_4$ (d) S_4N_4

GATE 2016

38. The reaction of P_2O_5 with HNO_3 and $HClO_4$, respectively, gives

(a) NO_2 and ClO_2 (b) N_2O_5 and Cl_2O_6 (c) N_2O_3 and Cl_2O_7 (d) N_2O_5 and Cl_2O_7

39. Sodium salt of pseudohalogens, X, Y and Z form colorless solutions in water. Solution of X decolorizes I_3^- solution with brisk effervescence. Solution of Y gives an intense red colour on reaction with Fe^{3+} solution. Solution of Z gives an intese blue color on reaction with a solution containing Fe^{3+} and Fe^{2+} ions. The pseudohalogens X, Y and Z respectively are

(a) CN^-, N_3^- and CNS^-

(b) N_3^-, CNS^- and CN^-

(c) N_3^-, CN^-, and CNS^-

(d) N_3^-, CNS^-, and CNO^-

QUANTA CHEMISTRY CLASSES

GATE 2017

40. In cyclophosphazenes $(NPX_2)_3$ (X = F, Cl, Br and Me), the strength of P – N π – bond varies with X in the order

(a) F > Cl > Br > Me (b) Me > F > Cl > Br (c) Br > Cl > F > Me (d) Me > Br > Cl > F

GATE 2018

41. The reaction of PCl^3 with PhLi in 1:3 molar ratio yields X as one of the products, which on further treatment with CH_3I gives Y. The reaction of Y with n-BuLi gives product Z. The product X, Y and Z respectively, are

(a) $[PPh_4]Cl, [Ph_2P=CH_2]$ and $Ph_2P(n-Bu)$

(b) $PPh_3, [Ph_3PI](CH_3)$ and $Ph_2P(n-Bu)_3$

(c) $PPh_3, [Ph_3P(CH_3)]I$ and $Ph_3P=CH_3$

(d) $[PPh_4]Cl, [Ph_3P=CH_2]$ and $[Ph_3P(n-Bu)]Li$

GATE 2019

42. Among the following carbon allotropes, the one with discrete molecular structure is

(a) Diamond (b) α-Graphite (c) β-Graphite (d) Fullerene

43. The INCORRECT statement about the silicones is

(a) They are thermally unstable because of the Si-C bond.

(b) They are insoluble in water.

(c) They are organosilicon polymers

(d) They have stable silica-like skeleton (–Si–O–Si–O–Si–)

44. Following are the examples of silicate minerals

(I) Zircon, $ZrSiO_4$ (II) Beryl, $Be_3Al_2Si_6O_{18}$ (III) Pyrophyllite, $Al_2(OH)_2[(Si_2O_5)_2]$

The correct structural description of the minerals is

(a) I–ortho silicate, II–Cyclic silicate and III–Sheet silicate

(b) I–ortho silicate, II–Sheet silicate and III–Cyclic silicate

(c) I–Cyclic silicate, II–Sheet silicate and III–Ortho silicate

(d) I–Sheet silicate, II–Ortho silicate and III–Cyclic silicate

QUANTA CHEMISTRY CLASSES

GATE 2020

45. The CORRECT statement about hexagonal boron nitride is:

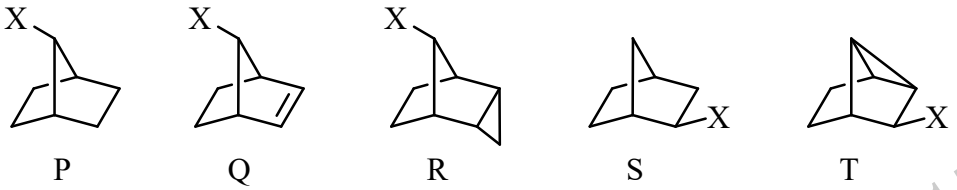
(a) It is reactive towards fluorine.

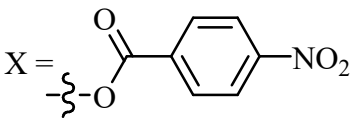
(b) It has same layer stacking as that of graphite.

(c) It is a good electrical conductor.

(d) It has lower thermal stability in air compared to that of graphite.

46. The rate of solvolysis of the given compounds is in the order:





(a) Q > T > R > P > S (b) T > Q > R > P > S (c) T > R > Q > S > P (d) R > T > Q > S > P

GATE 2021

47. The major product formed in the reaction of (2R, 3R) – 2 – bromo – 3 – methylpentane with NaOMe is:

(a) (2S, 3R) – 2 – methoxy – 3 – methylpentane

(b) (Z) – 3 – methylpent – 2 – ene

(c) (2R, 3R) – 2 – methoxy – 3 – methylpentane

(d) (E) – 3 – methyplent – 2 – ene

(2R, 3R) – 2 bromo – 3 – methyl pentane

48. The correct order of Lewis acid strengths of BF_2Cl, BFClFBr, BF_2Br and $BFBr_2$ is:

(a) $BFBr_2$ > BFClBr > BF_2Br > BF_2Cl

(b) BFClBr > $BFBr_2$ > BF_2Cl > BF_2Br

(c) BF_2Cl > BFClBr > BF_2Br > $BFBr_2$

(d) BF_2Cl > BF_2Br > BFClBr > $BFBr_2$

49. Reaction of $LiAlH_4$ with one equivalent of $Me_3N{\cdot}HCl$ gives a tetrahedral compound, which reacts with another equivalent of $Me_3N{\cdot}HCl$ to give compound N. The compound N and its geometry, respectively, are:

(a) $LiAlH_4NMe_3$ and trigonal bipyramidal

(b) $AlH_3(NMe_3)_2$ and trigonal bipyramidal

(c) Li_2AlH_4Cl and square pyramidal

(d) $AlH_3(NMe_3)_2$ and pentagonal

QUANTA CHEMISTRY CLASSES

MAIN GROUP ELEMENT

ANSWER KEY

1.	(d)	2.	(b)	3.	(a)	4.	(b)	5.	(a)	6.	(b)	7.	(b)
8.	(a)	9.	(b)	10.	(c)	11.	(a)	12.	(a)	13.	(a)	14.	(c)
15.	(b)	16.	(a)	17.	(c)	18.	(d)	19.	(b)	20	(b)	21.	(b)
22.	(b)	23.	(c)	24.	(a)	25.	(d)	26.	(d)	27.	(c)	28.	(d)
29.	(b)	30.	(a)	31.	(b)	32.	(d)	33.	(a)	34.	(4)	35.	(a)
36.	(c)	37.	(d)	38.	(d)	39.	(b)	40.	(a)	41.	(c)	42.	(*)
43.	(*)	44.	(*)	45.	(c)	46.	(c)	47.	(d)	48.	(a)	49.	(b)

QUANTA CHEMISTRY CLASSES

LANTHANIDE AND ACTINIDE

GATE 2005

1. The lanthanide complex (acac = acetylacetonate; phen = 1, 10 – phennathroline) that do not have square antiprismatic structure is

(a) $\left[Ce(NO_3)_6\right]^{2-}$ (b) $\left[La(acac)_3(H_2O)_2\right]$

(c) $\left[Ce(acac)_4\right]$ (d) $\left[Eu(acac)_3(Phen)\right]$

GATE 2006

2. The reaction between Pr_6O_{11} and dilute HCl leads to the formation of

(a) a cloured solution (b) only a black precipitate PrO_2

(c) a black precipitate of PrO_2 and soluble $PrCl_3$ (d) only soluble $PrCl_3$

GATE 2007

3. The separation of trivalent lanthanide ions, $Lu^{3+}, Yb^{3+}, Dy^{3+}, Eu^{3+}$ can be effectively done by a cation exchange resion using ammonia o – hydroxy isobutyrate as the eluent. The order n which the ions willl be separated is

(a) $Lu^{3+}, Yb^{3+}, Dy^{3+}, Eu^{3+}$ (b) $Eu^{3+}, Dy^{3+}, Yb^{3+}, Lu^{3+}$

(c) $Dy^{3+}, Yb^{3+}, Eu^{3+}, Lu^{3+}$ (d) $Yb^{3+}, Dy^{3+}, Lu^{3+}, Eu^{3+}$

GATE 2013

4. The correct electronic configuration and spin only magnetic moment of Gd^{3+} (atomic number 64) are

(a) $[Xe]4f^7$ and 7.9 BM

(b) $[Xe]4f^7$ and 8.9 BM

(c) $[Xe]4f^6 5d^1$ and 7.9 BM

(d) $[Rn]5f^7$ and 7.9 BM

GATE 2016

5. The calculated and observed magnetic moments differ considerably for an aqua complex of a Lanthanide (III) ion as a result of low lying states of high J. The ion, among the following, is

(a) Ce^{3+} (b) Pr^{3+} (c) Eu^{3+} (d) yb^{3+}

GATE 2017

6. The lanthanide ion the exhibits color in aqueous solution is

(a) La (III) (b) Eu (III) (c) Gd (III) (d) Lu (III)

GATE 2018

7. Generally, the coordination number and the nature of the electronic absorption band $(f \rightarrow f \text{ transition})$ of lanthanide (III) ion in their complexes are respectively

(a) greater than 6 and sharp (b) 6 and broad

(c) less than 6 and sharp (d) greater than 6 and broad

GATE 2020

8. In a uranium recovery process, an aqueous solution of uranyl ion is evaporated, dried in air at 400 ºC and subsequently reduced with hydrogen at 700ºC to obtain a uranium compound (X). The oxidation state of uranium in X is _____

(Given: atomic number of U is 92)

9. The experimental magnetic moment (3.4 BM) of a hydrated salt of Eu^{3+} at 27ºC is significantly different from the calculated value. The difference is due to

(Given: atomic number of Eu is 63)

(a) strong spin–orbit coupling.

(b) pairing of electrons in f-orbitals.

(c) population of electrons at higher J level(s) via thermal excitation.

(d) strong ligand field splitting of f-orbitals.

GATE 2021

10. The correct statement(s) about actinides is/are:

(a) The trans uranium elements are prepared artificially.

(b) The 5f electrons of actinides are bound less tightly than the 4f electrons.

(c) All the actinides are radioactive.

(d) Actinides do not exhibit actinide contraction.

QUANTA CHEMISTRY CLASSES

LANTHANIDE AND ACTINIDE

ANSWERS KEY

1.	(a)	2.	(a)	3.	(a)	4.	(a)	5.	(c)	6.	(b)	7.	(a)
8.	(+4)	9.	(?)	10.	(a,b,c)								

QUANTA CHEMISTRY CLASSES

NUCLEAR

GATE 2016

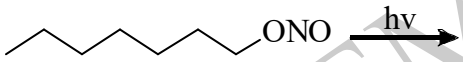
1. Among the following, the most stable isotope to radioactive decay is

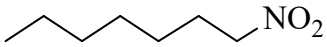
(a) $^{206}_{82}Pb$ (b) $^{210}_{82}Pb$ (c) $^{212}_{82}Pb$ (d) $^{214}_{82}Pb$

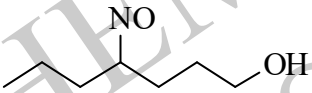
GATE 2017

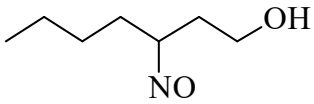
2. ^{210}Bi undergoes β^- decay to 1/8 of its initial amount in 15 days. The time required for its decay to 1/4 of its initial amount is _____ days (up to two decimal places)

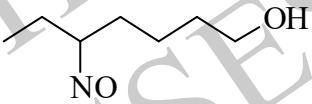
3. The major product formed in the following photochemical reaction is



(a) 

(b) 

(c) 

(d) 

GATE 2019

4. The total number of α and β particles emitted in the following radioactive decay is _____

$$^{238}_{92}U \rightarrow {}^{210}_{82}Pb$$

GATE 2020

5. The fission reaction of $^{235}_{92}U$ with thermal neutron is represented below.

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{236}_{92}U \begin{cases} \rightarrow {}^{99}_{41}Nb \rightarrow X_1 \rightarrow X_2 \rightarrow X_3 \\ \rightarrow {}^{133}_{51}Sb \rightarrow Y_1 \rightarrow Y_2 \rightarrow Y_3 \rightarrow Y_4 \end{cases}$$

$^{99}_{41}Nb$ and $^{133}_{51}Sb$ are the primary fission fragment pair, which undergo series of radioactive decay to form stable nuclei X_3 and Y_4 (chain enders). The X_3 and Y_4, respectively are:

(a) $^{99}_{44}Ru$ and $^{133}_{55}Cs$ (b) $^{96}_{41}Nb$ and $^{130}_{51}Sb$ (c) $^{93}_{38}Sr$ and $^{127}_{35}Ag$ (d) $^{87}_{35}Br$ and $^{124}_{43}Tc$

QUANTA CHEMISTRY CLASSES

GATE 2021

6. Given the initial weight of 1 mg of radioactive $^{60}_{27}Co$ (half-life = 5.27 years), the amount disintegrated in 1 year (rounded off to two decimal places) is _____ mg.

QUANTA CHEMISTRY CLASSES

NUCLEAR

ANSWERS KEY

1. (a) 2. (10.0029) 3. (b) 4. (11) 5. (b) 6. (0.123 mg)

QUANTA CHEMISTRY CLASSES

BIOINORGANIC

GATE 2005

1. The metal present at the active site of the protein carboxypeptidase A is

   (a) Zinc (b) molybdenum (c) magnesium (d) cobalt

2.

Column – I	Column – II
(P) Cytochromec	(I) Molybedenum
(Q) Calmodulin	(II) Potassium
(R) Chlorophyll	(III) Magnesium
(S) Alcohol dehydrogenase	(IV) Zinc
	(V) Iron
	(VI) Calcium

Codes:

(a) P – V, Q – VI, R – III, Q – V (b) Q – II, Q – III, Q – IV, Q – VI

(c) R – III, R – IV, R – VI, R – II (d) S – IV, S – V, S – II, S – IV

GATE 2006

3. Iron-sulphr clusters in biological systems are involved in

   (a) proton transfer (b) atom transfer (c) groups transfer (d) electron transfer

4. Amino acid side chain high affinity for Ca^{2+} and Cu^{2+} in metallo-proteins is:

   (a) carboxylate in both the cases. (b) imidazole in both the cases.

   (c) caboxylate for Ca^{2+} and imidazole for Cu^{2+}. (d) imidazole for Ca^{2+}.

5. When a reduced cytochrome transfers an electron from its Fe(II) to the bound O_2,

   (a) The bond oder of O_2 is reduced by one and ν_{O_2} decreases.

   (b) A metal bound superoxide is formed and ν_{O_2} decreases.

   (c) A metal bound superoxide is formed and ν_{O_2} increases.

   (d) The bond order of O_2 is reduced by one and ν_{O_2} increases.

6. In biological system, the metal ion invovlved in the dioxgyen transport besides Fe is

   (a) Co (b) Zn (c) Mg (d) Cu

QUANTA CHEMISTRY CLASSES

GATE 2008

7. In biological systems, the metal ions involved in electron transport are

(a) Na^+ and K^+ (b) Zn^{2+} and Mg^{2+} (c) Ca^{2+} and Mg^{2+} (d) Cu^{2+} and Fe^{3+}

GATE 2010

8. Among the following pair of metal ions present in Nature, the first one functions as an electrontransfer agent and the second one catalyzes the hydrolysis reactions. The correct pair is

(a) Fe and Zn (b) Mg and Fe (c) Co and Mo (d) Ca and Cu

GATE 2011

9. A well known naturally occuring organometallic compound is:

(a) vitamin B_{12} coenzyme (b) chlorophyll

(c) cytochrome p-450 (d) myoglobin

10. The red color of oxyhaemoglobin is mainly due to the

(a) d-d transition (b) metal to ligand charge transfer transition

(c) ligand to metal charge transfer transition (d) intraligand $\pi - \pi^*$ transition.

GATE 2014

11. Mg^{2+} is preferred in photosynthesis by chlorphyll because

(a) it has strong spin-orbit coupling (b) it has weak spin-orbit coupling

(c) it is a heavy metal (d) it binds strongly with chlorophyll

GATE 2015

12. Among the given pH values, the O_2 binding efficiency of hemoglobin is maximum at

(a) 6.8 (b) 7.0 (c) 7.2 (d) 7.4

13. Identify the function of hemocyanin and the metal responsible for it

(a) O_2 transport and Fe (b) O_2 transport and Cu

(c) electron transport and Fe (d) electron transport and Cu

GATE 2016

14. During oxygen transport by hemerythrin, oxygen is bound as

(a) O_2^- to one Fe(III) only (b) HO_2^- to one Fe(III) only

(c) O_2^{2-} to one Fe(II) and one Fe(III) (d) O_2^{2-} to two Fe(II)

QUANTA CHEMISTRY CLASSES

15. At pH 7.2 and 10 Torr oxygen partial pressure, the extent of O_2 binding is

(a) high for both haemoglobin and myoglobin (b) high for haemoglobin and low for myoglobin

(c) high for myoglobin and low for haemoglobin (d) low for both haemoglobin and myoglobin

16. Amongst the following, the group that is bound to the metal ion in coenzyme B_{12} is

(a) methyl (b) cyanide (c) adenosyl (d) hydroxyl

GATE 2017

17. The ν_{O-O} resonance Raman stretching frequency (in cm^{-1}) of the O_2 coordinated to iron centre in oxyhemoglobin is nearly

(a) 1100 (b) 850 (c) 1550 (d) 1950

18. The metal ion and the macrocyclic skeleton present in the green pigment of plants, respectively, are

(a) Mg(II) and chloring (b) Mg (II) and corrin

(c) Mn(II) and chlorin (d) Mg(II) and porphine

GATE 2018

19. The coordination geometries around the copper ion of plastocyanin (a blue-copper protein) in oxidized and reduced form, respectively are

(a) tetrahedral and square-planar (b) square-planar and tetrahedral

(c) distorted tetrahedral for both (d) ideal tetrahedral for both

20. The O_2 coordinated to metal ion centres in oxy-myoglobin and oxy-hemocyanin exists, respectively, as

(a) superoxide and peroxide (b) superoxide and superoxide

(c) peroxide and peroxide (d) superoxide and oxygen

GATE 2019

21. Match the metalloproteins with their respective functions.

P	Frritin	I	Electron transfer
Q	Rubredoxin	II	Acid base catalysis
R	Cobalamin	III	Metal storage
S	Carbonic anhydrase	IV	Methyl transfer

(a) P - III; Q - II; R - I; S - IV

(b) P - III; Q - I; R - IV; S - II

(c) P - IV; Q - I; R - III; S - II

(d) P - IV; Q - II; R - I; S - III

QUANTA CHEMISTRY CLASSES

GATE 2020

22. In oxyhemocyanin, the coordiantion number, mode of oxygen binding, color and the net magnetic behavior of copper ions, respectively are:

(Given: atomic number of Cu is 29)

(a) Four, μ-η^1:η^1-O_2^{2-}, blue and diamagnetic.

(b) Five, μ-η^2:η^2-O_2^{-}, colorless and paramagnetic.

(c) Five, μ-η^2:η^2-O_2^{2-}, blue and diamagnetic.

(d) Four, μ-η^1:η^1-O_2^{-}, colorless and paramagnetic.

23. The following table lists the reaction/conversion catalyzed by metalloenzymes.

Reaction/conversion		Metalloenzyme	
P	$R-H+O_2+2H^++2e^- \rightarrow R-OH+H_2O$	I	Coenzyme B_{12}
Q	$O_2+4e^-+8H^+ \rightarrow 2H_2O+4H^+$	II	Cytochrome P-450
R	$2H_2O_2 \rightarrow 2H_2O+O_1$	III	Cytochrome c oxidase
S	$NH_2-CH_2-CO_2H \rightarrow NH_2-CH(CH_2OH)-CO_2H$	IV	Catalase

(a) P-I; Q-IV; R-III; S-II

(b) P-II; Q-III; R-IV; S-I

(c) P-IV; Q-III; R-II; S-I

(d) P-II; Q-I; R-III; S-IV

GATE 2021

24. Which one of the following is a non-heme protein?

(a) hemoglobin (b) myoglobin (c) hemocyanin (d) cytochrome P-450

25. The correct statement(s) about the concentration of Na^+ and K^+ ions in animal cells is/are:

(a) $[K^+]$ inside the cell < $[K^+]$ outside the cell

(b) $[Na^+]$ inside the cell < $[Na^+]$ outside the cell

(c) $[Na^+]$ inside the cell > $[Na^+]$ outside the cell

(d) $[K^+]$ inside the cell > $[K^+]$ outside the cell

QUANTA CHEMISTRY CLASSES

BIOINORGANIC

ANSWER KEY

1.	(a)	2.	(d)	3.	(d)	4.	(c)	5.	(b)	6.	(d)	7.	(d)
8.	(a)	9.	(a)	10.	(d)	11.	(b)	12.	(d)	13.	(b)	14.	(b)
15.	(c)	16.	(c)	17.	(a)	18.	(a)	19.	(d)	20	(a)	21.	(b)
22.	(c)	23.	(c)	24.	(c)	25.	(b,d)						

QUANTA CHEMISTRY CLASSES

CHEMICAL BONDING

GATE 2005

1. The shape of the molecule XeO_2F_2 is

(a) distorted tetrahedral (b) square planar

(c) trigonal bipyramidal (d) tetrahedral

2.

Column – I (Molecular Species)	**Column – II (Bond order and magnetic property)**
P. O_2^-	I. 2.5, paramagnetic
Q. O_2	II. 2.0, diamagnetic
R. O_2^+	III. 1.5 diamagnetic
S. O_2^{2-}	IV. 1.0, diamagnetic
	V. 2.0, paramagnetic
	VI. 1.5, paramagnetic

Codes:

(a) P – III, Q – V, R – IV, S – III (b) P – II, Q – II, R – IV, S – III

(c) P – III, Q – V, R – IV, S – VI (d) P – VI, Q – V, R – I, S – IV

GATE 2006

3. $[XeO_6]^{4-}$ is octahedral whereas XeF_6 is a disordered one, because

(a) fluorine is more electronegative than oxygen

(b) Xe has a lone-pair in XeF_6

(c) XeF is neutrla whereas $[XeO_6]^{4-}$ is anionic.

(d) Xe-F bond has more ionic character

GATE 2007

4. The pair of compounds having the same hybridization for the central atom is

(a) XeF_4 and $[SiF_6]^{2-}$

(b) $[NiCl_4]^{2-}$ and $[PtCl_4]^{2-}$

(c) $Ni(CO)_4$ and XeO_2F_2

(d) $[Co(NH_3)_6]^{3+}$ and $[Co(H_2O)_6]^{3+}$

QUANTA CHEMISTRY CLASSES

GATE 2009

5. The geometry around the centrla atom in CIF_4^+ is

(a) square planar (b) square pyramidal

(c) octahedral (d) trigonal bipyramidal

6. Among the following, the isoelectronic and isostructural pair is

(a) CO_2 and SO_2 (b) SO_3 and SeO_3 (c) NO_2^+ and TeO_2 (d) SiO_4^{4-} and PO_4^{3-}

GATE 2010

7. According to VSEPR model, the shape of $\left[XeOF_5\right]^-$ is

(a) Octahedral (b) Trigonal bipyramidal

(c) square pyramidal (d) pentagonal monopyramidal

GATE 2011

8. According to VSEPR theory the shapes of $\left[SF_2Cl\right]^+$ and $[S_2O_4]^{2-}$ should be

(a) trigonal planar for $[S_2O_4]^{2-}$ and trigonal pyramidal for $[SF_2Cl]^+$

(b) both trigonal planar

(c) trigonal pyramidal for $[S_2O_4]^{2-}$ and trigonal planar for $[SF_2Cl]^+$

(d) both trigonal pyramidal

GATE 2015

9. The compound with planr geometry is

(a) $N(t\text{–}Bu)_3$ (b) NPh_3 (c) NF_3 (d) $N(SiH_3)_3$

10. The point group of IF_7 is

(a) D_{6h} (b) D_{5h} (c) C_{6v} (d) C_{5v}

GATE 2016

11. The shapes of XeF_5^+ and XeF_5^-, respectively, are

(a) pentagonal planar and square pyramidal

(b) pentagonal planar and trigonal bipyramidal

(c) square pyramidal and pentagonal bipyramidal

(d) square pyramidal and pentagonal planar

QUANTA CHEMISTRY CLASSES

GATE 2019

12. The INCORRECT statement about the interhalogen compound ICl_3 is

(a) It exists as a dimer

(b) Geometry around the iodine is tetrahedral in solid-state

(c) It decomposes as ICl and Cl_2 in gas-phase

(d) Liquid ICl_3 conducts electricity

GATE 2020

13. Among the following species, the one that has pentagonal shape is:

(Given: atomic numbers of O, F, S, I and Xe are 8, 9, 16, 53 and 54, respectively)

(a) $[SF_5]^-$ (b) $XeOF_4$ (c) $[XeF_5]^-$ (d) IF_5

GATE 2021

14. The shapes of the compounds

ClF_3, $XeOF_2$, N_3^- and XeO_3F_2

respectively, are:

(a) trigonal planar, T-shape, V-shape and square pyramidal

(b) trigonal planar, trigonal planar, V-shape and trigonal bipyramidal

(c) T-shape, T-shape, linear and trigonal bipyramidal

(d) T-shape, trigonal planar, linear and square pyramidal

QUANTA CHEMISTRY CLASSES

CHEMICAL BONDING

ANSWERS KEY

1.	(a)	2.	(d)	3.	(b)	4.	(d)	5.	(d)	6.	(b)	7.	(d)
8.	(a)	9.	(d)	10.	(b)	11.	(d)	12.	(?)	13.	(d)	14.	(c)

QUANTA CHEMISTRY CLASSES

ANALYTICAL

GATE 2014

1. In atomic absorption spectroscopy, the atomization process utilizes
(a) flame (b) electric field (c) magnetic field (d) electron beam

GATE 2019

2. On heating a sample of 25 mg hydrated compound (molecular weight = 250 g/mol) in thermogravimetric analysis, 16 mg of dehydrated compound remains. The number of water molecules lost per molecule of hydrated compound is _____.
(Molecular weight of water = 18 g/mol)

GATE 2021

3. The quantity of the cobalt ore [$Co_3(AsO_4)_2 \cdot H_2O$] required to obtain 1 kg of cobalt (rounded off to two decimal places) is_____ kg.
[Atomic Wt. of Co = 59, As = 75, O = 16, H = 1]

QUANTA CHEMISTRY CLASSES

ANALYTICAL

ANSWERS KEY

1. (a) 2. (5) 3. (2.672 kg)

QUANTA CHEMISTRY CLASSES

INSTRUMENTAL METHOD (INORGANIC SPECTRA)

GATE 2006

1. A radical contains $^{14}N(I=1)$ with hyperfine constant 1.61 mT and two equivalent protons (I=1/2) with hyperfine constant 0.35 mT. The ESR spectrum will exhibit.

   (a) 3 lines (b) 6 lines (c) 7 lines (d) 9 lines

2. In the prooton decoupled ^{13}C and ^{31}P NMR spectra of $(CH_3)_3P=0$, the number of lines observed, respectively, are

   (a) two and one (b) one and two (c) three and one (d) two and two.

GATE 2008

3. If ClF_3 were to be stereochemically rigid, its ^{19}F NMR spectrum (I for $^{19}F=\frac{1}{2}$) would be (assume that Cl is not NMR active)

   (a) a doublet and a triplet
   (b) a singlet
   (c) a doublet and a singlet
   (d) two singlets

4. Compound X is:

   (a) $(CH_3O_3)P$ (b) $(CH_3O)_2P(O)$

   (c) $(CH_3O)_2P(O)(OH)$ (d) $(CH_3O)_3PH$

5. Upon heating, compound X is converted to Y, which has the same molecular formula as that of X. The ^1H NMR spectrum of Y shows two doublets centered at 3.0 ppm (separation of two lines ~ 20 Hz) and 4.0 ppm (separation of two ~ 15 Hz) respectively.

   Compound Y is:

   (a) $(CH_3O)_2P(O)(OH)$
   (b) $(CH_3O)_3P(O)$
   (c) $(CH_3O)_2(CH_3)P(O)$
   (d) $(CH_3O)_2(CH_3)P(OH)$

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GATE 2009

6. The ^{31}P NMR spectrum of P_4S_3 consists of

(a) a singlet (b) a doublet and a triplet

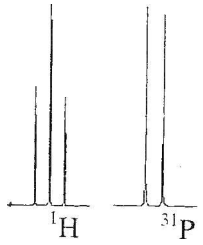
(c) a doublet and a quartet (d) two doublets.

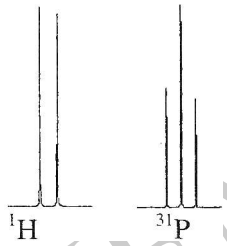
7. The ^{1}H NMR spectrum of HD consists of a

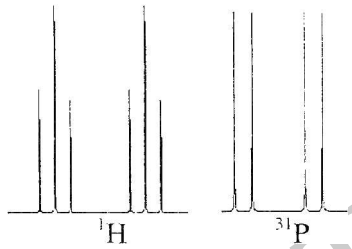
(a) singlet (b) 1:1 doublet (c) 1:1:1 triplet (d) 1:2:1 triplet.

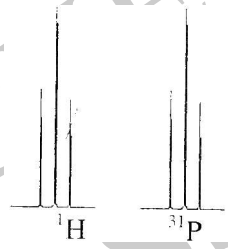
GATE 2011

8. The correct pair of ^{1}H and ^{31}P NMR spectral patterns for $C(H)(F)(PCl_2)_2$ is:

(a) 

(b) 

(c) 

(d) 

GATE 2012

9. The extent of Mossbauer quadrupole splitting of iron follows the order

(a) $FeCl_2 \cdot 4H_2O > K_2\left[Fe(CN)_5(NO)\right] > FeCl_3 \cdot 6H_2O$

(b) $K_2\left[Fe(CN)_5(NO)\right] < FeCl_2 \cdot 4H_2O > FeCl_3 \cdot 6H_2O$

(c) $FeCl_3 \cdot 6H_2O > K_2\left[Fe(CN)_5(NO)\right] > FeCl_2 \cdot 4H_2O$

(d) $FeCl_2 \cdot 4H_2O > FeCl_3 \cdot 6H_2O > K_2\left[Fe(CN)_5(NO)\right]$

GATE 2015

10. The value of 'g' and the number of signals observed for the references standard, diphenylpicry lhydrazyl (DPPH), in the solid stae ESR spectrum are, respectively

(a) 2.0036 and 1

(b) 2.0036 and 3

(c) 2.2461 and 1

(d) 2.2416 and 3

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GATE 2016

11. The ^{19}F NMR spectrum of ClF_3 when measured at –60ºC will be observed as a

(a) singlet (b) doublet

(c) doublet and triplet (d) doublet of doublet and a doublet of triplet

GATE 2017

12. The characteristic feature of an electronic spin resonance (ESR) spectrum of frozen aqueous solution of $CuSO_4 \cdot 5H_2O$ at 77 K is

(a) $g_{\|} > g_{\perp}$ (b) $g_{\|} < g_{\perp}$ (c) $g_{\|} = g_{\perp}$ (d) $g_x \neq g_y \neq g_z$

GATE 2019

13. In the EPR spectrum of a methyl radical, the number of the lines and their relative intensities, respectively, are

(a) 1 and 1 (b) 3 and 1 : 2 : 1 (c) 4 and 1 : 2 : 2 : 1 (d) 4 and 1 : 3 : 3 : 1

GATE 2020

14. The total number of $g_{\|}$ lines expected in the EPR spectrum of a solution of bis(salicylaldimine) copper(II) having pure ^{63}Cu and ^{14}N at 77 K is _____

(Given: I values of ^{63}Cu, ^{14}N and ^{1}H are $\frac{3}{2}$, 1 and $\frac{1}{2}$, respectively)

QUANTA CHEMISTRY CLASSES

INSTRUMENTAL METHOD (INORGANIC SPECTRA)

ANSWER KEY

1.	(d)	2.	(?)	3.	(?)	4.	(a)	5.	(b)	6.	(c)	7.	(c)
8.	(c)	9.	(a)	10.	(a)	11.	(c)	12.	(a)	13.	(d)	14.	(60 line)

QUANTA CHEMISTRY CLASSES

PERODIC

GATE 2019

1. Gas phase bond length and dipole moment of a compound (MX) is 3Å and 10.8 D, respectively. The ionic character in gas phase MX is _____% (Round off to one decimal place)

(1D = 3.336×10^{-30} C m)

GATE 2021

2. $\oplus$ and $\odot$ are two operators on number p and q such that

$$p \oplus q = \frac{p^2 + q^2}{pq} \text{ and } p \odot q = \frac{p^2}{q};$$

If $x \oplus y = 2 \odot 2$, then x =

(a) $\frac{y}{2}$ (b) $\frac{3y}{2}$ (c) y (d) 2y

QUANTA CHEMISTRY CLASSES

PERODIC

ANSWER KEY

1. (75%) 2. (?)

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